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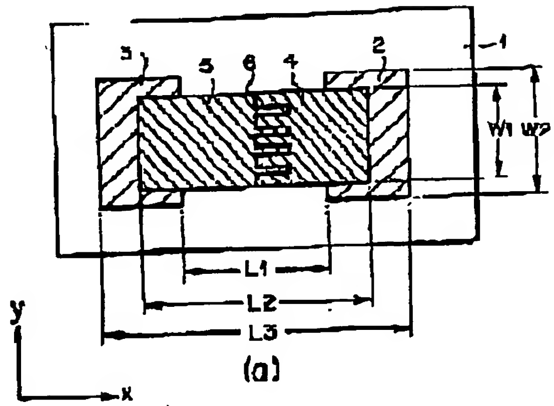

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APPLICANT : CANON INC;

INVENTOR : ASAI AKIRA;

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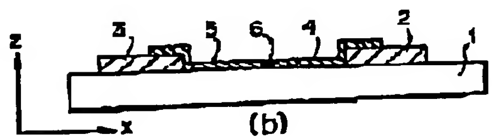
TITLE : ELECTRON EMISSION DEVICE, IMAGE FORMING DEVICE USING IT, AND MANUFACTURE FOR THESE



ABSTRACT : PROBLEM TO BE SOLVED: To improve efficiency, defined to be a ratio of the current flowing through a surface conduction electron emission element to the current of electrons migrating to a pull-up electrode by controlling an electric field applied to electrons, emitted in advance into the outside (vacuum) of an element.

SOLUTION: This device consists of an electron emission element having a conductive film containing an electron emission part, and an electrode for pulling up electrons. In this case, an electrically insulated long narrow region 6 is formed on the conductive films 4 and 5, so as to divide the conductive films 4 and 5 between a high and low electric potential section. The shape of the insulated region 6 is roughly periodical, as a combination of a part bent toward a high electric potential section with a part bent toward a low electric potential section. The part bent toward a high electric potential section in a period of the insulated region 6 includes the continuous electric emission part in a linearly continuos shape.

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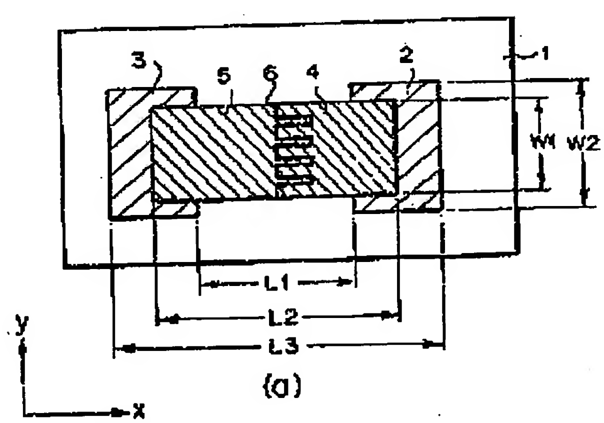
(54)【発明の名称】　電子放出装置、それを用いた画像形成装置及びそれらの製造方法

(57)【要約】
【課題】　本発明の課題は、既に素子外部（真空中）に放出された電子が受ける電界の制御を行い、表面伝導型電子放出素子を流れる電流量と引き上げ電極に到達する電子の電流量との比であるところの効率を向上させる事である。
【解決手段】　その一部に電子放出部を含む導電性薄膜を有する電子放出素子、及び電子を引き上げるための電極によって構成される電子放出装置において、該導電性薄膜4，5を高電位側と低電位側とに分割するように、電気的に絶縁された細長い領域6が該導電性薄膜に１本形成されており、該絶縁領域6が高電位側に凸になった



【特許請求の範囲】

【請求項１】　その一部に電子放出部を含む導電性薄膜を有する電子放出素子、及び電子を引き上げるための電極によって構成される電子放出装置において、
該導電性薄膜を高電位側と低電位側とに分割するように、電気的に絶縁された細長い領域が該導電性薄膜に１本形成されており、該絶縁領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る概略周期的な形状を持ち、且つ、絶縁領域の１周期の中で高電位側に凸になった部分の少なくとも一部に連続的な線状の電子放出部が存在していることを特徴とする電子放出装置。

【請求項２】　上記電子放出部及びその近傍に、炭素及び／または炭素化合物より成る堆積物を有することを特徴とする請求項１記載の電子放出装置。

【請求項３】　上記絶縁領域の１周期中に含まれる電子放出部の長さｌｅと該絶縁領域の周期ｌｐと該絶縁領域の高電位側に凸になった部分と、低電位側に凸になった部分の蛇行距離ｌａが、それぞれ次式の範囲にあることを特徴とする請求項１又は２記載の電子放出装置。

$5\mu m \leq lp \leq 80\mu m$

$1\mu m \leq le \leq 40\mu m$

$1\mu m \leq la \leq 100\mu m$

【請求項４】　上記電子放出素子が、さらに、対向する一対の素子電極を有し、該導電性薄膜の分割された上記高電位側と低電位側のそれぞれの部分が、上記素子電極のそれぞれの側に電気的に接続され、且つ該素子電極に挟まれた領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る周期的な形状を有し、
上記導電性薄膜が上記素子電極に挟まれる領域の内、主に高電位側に凸になった部分に存在することを特徴とする請求項１～３のいずれかに記載の電子放出装置。

【請求項５】　上記電子放出素子が、表面伝導型電子放出素子であることを特徴とする請求項１～４のいずれかに記載の電子放出装置。

【請求項６】　その一部に電子放出部を含む導電性薄膜を有する電子放出素子、及び電子を引き上げるための電極によって構成される電子放出装置において、
該導電性薄膜を高電位側と低電位側とに分割するように、電気的に絶縁された細長い領域が該導電性薄膜に１本形成されており、該絶縁領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る概略周期

$5\mu m \leq lp \leq 80\mu m$

$1\mu m \leq le \leq 20\mu m$

$5\mu m \leq la \leq 100\mu m$

$Va/H \leq 0.5\times 10^{6}$ [V／m]

【請求項７】　上記電子放出部及びその近傍に、炭素及び／または炭素化合物を有することを特徴とする請求項６記載の電子放出装置。

【請求項８】　上記電子放出素子が、表面伝導型電子放出素子であることを特徴とする請求項６又は７記載の電子放出装置。

【請求項９】　請求項１～８のいずれかに記載の電子放出装置を構成するいずれかの電子放出素子が基体上に複数配置された電子源と、電子を引き上げるための電極によって構成されることを特徴とする電子放出装置。

【請求項１０】　上記電子源において、電子放出素子に電気的に接続された配線が、マトリクス状に形成されていることを特徴とする請求項９記載の電子放出装置。

【請求項１１】　上記電子源において、電子放出素子に電気的に接続された配線が、はしご状に形成されていることを特徴とする請求項９記載の電子放出装置。

【請求項１２】　請求項９～１１のいずれかに記載の電子放出装置の構成を有し、上記電子引き上げ電極が上記電子源から放出される電子線の照射により、発光して画像を形成する画像形成部材の機能を有することを特徴とする画像形成装置。

【請求項１３】　請求項１に記載の電子放出装置の製造方法であって、上記絶縁領域の内電子放出部以外の部分を、上記導電性薄膜を、集束イオンビーム法、レーザー加工法、ないしフォトリソグラフィー法のいずれかの微細加工技術により導電性薄膜の一部を除去することにより形成し、次いで該導電性薄膜に電圧を印加し電流を流すことにより、電子放出部を形成することを特徴とする電子放出装置の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電子源およびその応用である表示装置等の画像形成装置にかかわり、特に、新規な構成の表面伝導型電子放出素子またそれを使用した電子放出装置、電子源およびその応用である表示装置等の画像形成装置に関する。

【０００２】

【従来の技術】表面伝導型電子放出素子を利用した電子

【0004】図25は従来の表面伝導型電子放出素子の概略図である。(a)が素子を真上から見たもので、(b)が横からみたものである。1は基板であり、2は素子陽電極であり、3は素子陰電極であり、不図示の電源とつながっている。5004および5005は導電性薄膜であり、5004は素子陽電極2と5005は素子陰電極3と電気的に連結されている。電極2、3の膜厚は、数10nmから数μm程度のものである。他方、導電性薄膜5004、5005の膜厚は、1［nm］から数10［nm］程度のものである。5006は亀裂で、導電性薄膜5004と5005とを電気的にほぼ不連続にしている。亀裂の特徴については製造工程において述べるが、素子が形成された後には電子は亀裂5006の素子陽極の先端部近傍から散乱射出している。

【0005】次に表面伝導型電子放出素子を使用した電子放出装置について、図26に沿って説明する。

【0006】図26は、図25で示した構成を有する表面伝導型電子放出素子を使用した電子放出装置の概略構成図である。

【0007】10は素子に素子電圧Vfを印加するための電源、11は素子電極2、3間を流れる素子電流Ifを測定するための電流計、12は素子の電子放出部より放出される到達電流Ieを捕捉するための引き上げ電極、13は引き上げ電極12に電圧Vaを印加するための高圧電源、14は表面伝導型電子放出素子より放出され引き上げ電極に到達した電流Ieを測定するための電流計である。さらに、必要に応じて、電子の到達位置の分布を測定できるようにメッシュ状の電極あるいは、蛍光板が引き上げ電極12に取り付けられている。電子を放出させるにあたっては、素子電極2、3に電源10が接続し、該電子放出素子と引き上げ電極12とに電源13が接続している。更に、素子電流IfとIeを測定する際には、図のように電流計11と14がそれぞれ接続している。

【0008】真空容器16のなかに、表面伝導型電子放出素子および引き上げ電極は図のように設置されており、真空容器外から、それぞれの電圧等は制御できるようになっている。尚、排気ポンプ15は、ターボポンプ、ロータリーポンプからなる通常の高真空排気系と、更に、イオンポンプからなる超高真空排気系からなる。また、真空容器16全体、及び電子放出素子基板は、不図示のヒーターにより加熱できる。

さ0.5［μm］程度のシリコン酸化膜をスパッタ法で形成した基板1の上に素子電極2、3のホトレジストパターン（ネガ）を形成し、真空蒸着法により例えば厚さ5［nm］のTi、厚さ100［nm］のNiを順次堆積する。ホトレジストパターンを有機溶剤で溶解し、Ni／Ti堆積膜をリフトオフして、素子電極2、3を形成する（図27（a））。

【0012】［工程－b］続いて、膜厚100［nm］程度のCr膜を真空蒸着により堆積し、ホトリソグラフィー技術により、導電性薄膜の形状に対応する開口を有するようにパターニングし、その上に有機Pd化合物（ccp4230奥野製薬（株）社製）をスピンナーにより回転塗布、つづいて加熱焼成処理をすることにより主として酸化パラジウムよりなる微粒子からなる導電性薄膜7を形成する。なおここで述べる微粒子膜とは、複数の微粒子が集合した膜であり、その微細構造として、微粒子が個々に分散配置した状態のみならず、微粒子が互いに隣接、あるいは、重なり合った状態（島状も含む）の膜を指す。

【0013】［工程－c］Cr膜を酸エッチャントによりエッチングしてリフトオフにより所望の導電性薄膜7のパターンを形成する（図27（b））。

【0014】［工程－d］次に、図26の電子放出装置に素子を設置し、真空ポンプにて排気し、2.7×10^{-3}Pa（2×10^{-5}Torr）程度の真空度に達した後、素子に素子電圧Vfを印加するための電源10によって、素子電極2、3間にそれぞれ電圧を印加し、フォーミングと呼ばれる通電処理を行う。これは、電源10により、電圧をパルス状にして、昇電圧しながら通電処理するものである。この通電処理により導電性薄膜7は局所的に破壊、変形もしくは変質し、亀裂部5006が形成される（図27（c））。また、同時に、フォーミング処理中に、導電性薄膜7が局所的に破壊、変形しない程度の電圧、例えば0.1［V］程度の電圧で、通電パルス間に抵抗測定パルスを挿入し、抵抗を測定する。フォーミング処理の終了は、その測定によって、導電性薄膜7の抵抗が約1Mオーム以上になった時とし、このときに、素子への電圧の印加を終了する。

【0015】［工程－e］フォーミングを終えた素子には活性化工程と呼ばれる処理を施すのが望ましい。活性化工程とは、この工程により、素子電流If、到達電流Ieが、著しく変化する工程である。活性化工程は、例

は、前述の応用の形態、真空容器の形状や、有機物質の種類などにより異なるため、場合に応じて適宜設定される。適当な有機物質としては、アルカン、アルケン、アルキンの脂肪族炭化水素類、芳香族炭化水素類、アルコール類、アルデヒド類、ケトン類、アミン類、フェノール、カルボン、スルホン酸等の有機酸類などを挙げることが出来、具体的には、メタン、エタン、プロパンなどC_nH_{2n+2}で表される飽和炭化水素、エチレン、プロピレンなどC_nH_{2n}等の組成式で表される不飽和炭化水素、ベンゼン、トルエン、メタノール、エタノール、ホルムアルデヒド、アセトアルデヒド、アセトン、メチルエチルケトン、メチルアミン、エチルアミン、フェノール、蟻酸、酢酸、プロピオン酸などあるいはこれらの混合物が使用できる。この処理により、雰囲気中に存在する有機物質から、炭素あるいは炭素化合物が素子上に堆積し、素子電流If、到達電流Ieが、著しく変化するようになる。活性化工程の終了判定は、素子電流Ifと到達電流Ieを測定しながら、適宜行う。なお、パルス幅、パルス間隔、パルス波高値などは適宜設定される。炭素及び炭素化合物とは、例えばグラファイト（いわゆるHOPG、PG、GCを包含する。ここで、HOPGはほぼ完全なグラファイトの結晶構造、PGは結晶粒が２０［ｎｍ］程度で結晶構造がやや乱れたものである。）、非晶質カーボン（アモルファスカーボン及び、アモルファスカーボンと前期グラファイトの微結晶の混合物を指す）であり、その膜厚は、５０［ｎｍ］以下の範囲とするのが好ましく、３０［ｎｍ］以下の範囲とすることがより好ましい。この炭素化合物の堆積により亀裂の実効幅が狭くなり、電子は陰極先端から散乱放出する事となる。また、このようにして得られた素子において電子が放出する場所は、０［ｎｍ］～１００［ｎｍ］の測度で亀裂方向に平均化すると亀裂に沿って連続に分布していることが知られている。つまり、１０［ｎｍ］～１００［ｎｍ］の解像度で見ると電子放出点はほぼ連続かつ均一に存在している。

【００１６】このような工程を経て得られた電子放出素子は、安定化工程を行うことが好ましい。この工程は、真空容器内の有機物質を排気する工程である。真空容器１６を排気する真空ポンプ１５は、装置から発生するオイルが素子の特性に影響を与えないように、オイルを使用しないものを用いるのが好ましい。具体的には、ソープションポンプ、イオンポンプ等の真空排気装置を挙げ［illegible］ましい。さらに真空容器内を排気するときには、真空容器全体を加熱して、真空容器内壁や、電子放出素子に吸着した有機物質分子を排気しやすくするのが好ましい。このときの加熱条件は、摂氏８０から２５０度好ましくは１５０度以上で、できるだけ長時間処理するのが望ましいが、特にこの条件に限るものではなく、真空容器の大きさや形状、電子放出素子の構成などの諸条件により適宜選ばれる条件によって行う。真空容器内の圧力は極力低くすることが必要で、1.3×10^{-5}Pa（1×10^{-7}［Torr］）以下が好ましく、さらに1.3×10^{-6}Pa（1×10^{-8}［Torr］）以下が特に好ましい。安定化工程を行った後の、駆動時の雰囲気は、上記安定化処理終了時の雰囲気を維持するのが好ましいが、これに限るものではなく、有機物質が十分除去されていれば、真空度自体は多少低下しても十分安定な特性を維持することができる。このような真空雰囲気を採用することにより、新たな炭素あるいは炭素化合物の堆積を抑制でき、また真空容器や基板などに吸着したH_2O、O_2なども除去でき、結果として素子電流If、到達電流Ieが安定する。

【００１７】上述のような素子構成と製造方法によって作成された該電子放出装置の基本特性について図２８を用いて説明する。図２６に示した電子放出装置により測定された到達電流Ieおよび素子電流Ifと素子電圧Vfの関係の典型的な例を図２８に示している。図２８は、到達電流Ieは素子電流Ifに比べて著しく小さいので、任意単位で示されている。いずれの軸も、リニアスケールで表されている。

【００１８】図２８からも明らかなように、該電子放出装置は到達電流Ieと素子電圧Vfの関係に対して次の三つの特性を有する。まず第一に、該電子放出装置はある電圧（しきい値電圧と呼ぶ、図２８のVth）以上の素子電圧を印加すると急激に到達電流Ieが増加し、一方しきい値電圧Vth以下では到達電流Ieがほとんど検出されない。すなわち、到達電流Ieに対する明確なしきい値電圧Vthを持った非線形素子である。第二に、到達電流Ieが素子電圧Vfに依存するため、到達電流Ieは素子電圧Vfで制御できる。第三に、引き上げ電極１２に捕捉される到達電荷量は、素子電圧Vfを印加する時間に依存する。すなわち、引き上げ電極１２に捕捉される電荷量は、素子電圧Vfを印加する時間により制御できる。

【００２０】この原理に基づき電子放出装置を複数構成する事によって、平板型画像表示装置を形成する事が可能となる。その構成方法については、特開平７－２３５２５５号公報に詳しく記載されている。簡単に述べると、平板型画像表示装置の画素に対応して、上記の表面伝導型電子放出素子を同一基板上に複数配置し、それぞれの素子電極２、３からの配線をいわゆる単純マトリクス状にそれぞれ行配線、列配線とするように配置する。また、引き上げ電極は共通のものを使用するが、引き上げ電極上には各電子放出素子に対応した位置に蛍光膜が塗布され、画素を形成している。従って、引き上げ電極によって引き上げられた電子によって、画素を点灯させる事が可能となる。駆動においては、行配線には選択的に正の電位Ｖ（Ｖｔｈ＞Ｖ＞Ｖｔｈ／２）を付与し、列配線には選択的に負の電位－Ｖ（Ｖｔｈ＞Ｖ＞Ｖｔｈ／２）を付与する事により、行列ともに選択された素子のみが、Ｖｔｈを越える素子電圧がかかる事になる。この事と上述した表面伝導型電子放出素子を使用した電子放出装置の特性によって、行列ともに選択された素子のみを駆動できるようになる。

【００２１】更に、上述のような一般的な表面伝導素子を使用した電子放出装置以外にも次のような発明が本出願人によりなされている。即ち、特開平１－３１１５３２号公報及び、特開平１－３１１５３３号公報及び、特開平１－３１１５３４号公報において、素子陽極と素子陰極が対称な形状を持っていないＳＣＥ素子が提案されている。特開平１－３１１５３２号公報及び、特開平１－３１１５３３号公報及び、特開平１－３１１５３４号公報においては、電子ビームの引き上げ電極での到達形状の整形を目的としていた。その為、電子は本発明では、以下で述べるように、この目的とは異なる課題を解決するために本発明を提案する。

【００２２】

【発明が解決しようとする課題】上記の従来例で記述した電子放出装置の原理に従った平板型表示装置において、素子電流量Ｉｆに対して、引き上げ電極１２に到達する電子の到達電流量Ｉｅの比である効率η、（η＝Ｉｅ／Ｉｆ）が大きい事が望ましい。すなわち、ηを大きくできれば、同様のＩｅを得るのに必要なＩｆを小さくできるので、素子を結ぶ配線の設計を容易にできたり、素子の劣化を低減できる事が予想される。

【００２３】従って、本発明の解決しようとする課題

面伝導型電子放出素子の導電性薄膜には亀裂が存在し、該亀裂は、導電性薄膜を素子陽極に電気的に連結した部分と素子陰極にそれぞれ電気的に連結した部分とを分けるように形成されている。この薄膜亀裂のうち、ｎｍオーダーの幅を持っている箇所が有限の長さ存在する事が判ってきている。更に様々な検証実験とコンピュータシミュレーションによって、該ｎｍオーダーの亀裂の高電位薄膜部側の先端部分から電子がほぼ等方に放出される事が判っている（正確には高電位薄膜部の先端部から電子が等方に放出されると仮定すると実験とシミュレーションとが矛盾なく一致する事が判っている。）。ここで高電位薄膜部とは、導電性薄膜部５００４と素子陽極２等を含めたほぼ等電位と見なせる電気的に連結されたものの事である。同様に、導電性薄膜５００５と素子陰極３等を含めたほぼ等電位と見なせる部分を低電位薄膜部と以下呼ぶ。

【００２６】このように高電位薄膜の先端から放出された電子の振る舞いは、電界放出型電子放出素子のように、陰極側から放出される電子とは異なった振る舞いをする事が静電場中の電子の運動を考察する事によってわかる。以下表面伝導型電子放出素子を用いた電子放出装置の特徴的な電子の運動を考察する。

【００２７】実際の表面伝導型電子放出素子における亀裂は不規則に蛇行しており、その振幅は素子の形成方法等に依存するが、素子陽電極と素子陰電極の間の幅の半分程度以下であるものが多い。従って、素子の蛇行まで考慮した理論を構成する必要があるが、ここではまず簡単のために、蛇行の振幅が小さい場合の素子とそれに対応した理論モデルについて、先に述べる。つまり、亀裂部分が直線になっている場合の静電的な電位分布について述べる（図５、ここで後述するように図５は各オーダーの電位分布の断面図を示している。）（亀裂が蛇行している場合の考察は、直線亀裂での電子の運動等を議論した後に詳細に考察し、本発明での課題を述べる事とする。）。

【００２８】亀裂３０部が直線でかつ、素子の電極および薄膜部の表面がｚ＝０面上にあり、今考えている領域（図６の３４、後で詳しくのべる。）と比較して、十分大きい面積を持って広がっているとし、またその電位分布が高電位薄膜部３１側と低電位薄膜部３２側とで完全に２値化しているとみなしてよいときは、高電位薄膜部側３１と低電位薄膜部３２を静電学的に、対向する２電

式（1）

$$E_x + iE_z = \frac{V_f}{2\pi}\frac{-i}{\sqrt{(x-iz)^2-(D/2)^2}} + i\frac{V_a}{H}$$

として与えられる。ここで、i＝√（－1），πは円周率である。座標の中心は、亀裂の中央としており、Dは実効的な亀裂の幅である。V_fは図28で示したように、素子にかかる電圧で、0から数10［V］程度である。また、V_aは引き上げ電極と素子との間の電圧で、数［KV］から数10［KV］程度で、素子と蛍光板との距離Hは数［mm］オーダーである。したがって、V_a／Hがほぼ10^6［V／m］から10^7［V／m］のオーダーとなる。

【0030】また、実効的な幅Dというのは、亀裂中央から亀裂の大きさの数10倍程度の位置で実際の電界と一致するように上記の式（1）とをフィッティングした際のパラメータとしての幅の意味である。この幅は表面伝導型電子放出素子においては数nm程度のオーダーで＊ある事が経験的にわかっている。

【0031】式（1）で記述される電界を積分した電位分布をスケール別に表したものが図5である。図5で、（a）は［mm］オーダーの電位分布図である。（b）は［μm］オーダーの電位分布図であり、（c）は［nm］オーダーの電位分布図である（式（1）で近似される。亀裂、高電位薄膜部、低電位薄膜部、引き上げ電極12をそれぞれ、30、31、32、33と呼び、それに対応するものを図5に記している。）。

【0032】この時、z＝0面上、亀裂（y軸）に平行でかつ、xの値が、

【0033】

【数2】

式（2）

$$x_S := \frac{D}{2}\sqrt{1+\left(\frac{2V_fH}{V_aD\pi}\right)^2}$$

の直線上において、電界がゼロとなる事がわかる。電位の調和関数としての性質により、電位を複素流体ポテンシャルの虚部とみなした際、その流れ場が淀む点は、電界ゼロの点に対応する。流体と静電場とのアナロジーから、この電界が淀む直線状の箇所を、以下、淀み線あるいは、（x，z）面の断面形状を捕えて、淀み点35と※呼ぶ。この淀み点35の中心からの距離x_sは、この系の特徴を表わす長さである。

【0034】該電子放出装置におけるオーダーでは、$x_s \gg D$となり、x_sは充分よい近似で、

【0035】

【数3】

式（3）

$$x_S = \frac{V_f}{\pi}\frac{H}{V_a}$$

となり、実効的な幅Dにx_sが依存しない事がわかる。（$x_s \gg$数［nm］）。V_a＝1［KV］，V_f＝15［V］，H＝5［mm］では、x_s＝23.9［μm］程度である。★

★【0036】（3）式の近似は、電界分布を

【0037】

【数4】

式（4）

$$E_x + iE_z = -\frac{V_f}{2\pi}\frac{i}{x-iz} + i\frac{Va}{H}$$

と近似した事に相当し、この近似はx_sと亀裂幅の比が充分大きいとき、すなわち亀裂30中央から実効的な亀裂

☆た電子放出装置の特徴的な電界は、回転電界と縦電界の和で近似できるという事がわかる。

となる。ここで、Imは虚数部をあらわす。

【0040】式（1）で与えられた電場を解析すると高電位薄膜部31側に、電界がz軸正の向きのベクトル成分をもつ領域が存在する事がわかる。その領域の形状は、亀裂30中央と淀み点35との中央を中心軸として、半径をx_sの半分とするほぼ半円をy軸方向の平行移動によって得られる内部のつまった半円柱状に形成されている事がわかる。この領域では、電子は下向きの力を受けるので、以下これを負の勾配領域36と呼ぶ。図5（b）に対応する領域を斜線で示した。式（4）の近似がなりたつときには、この負の勾配領域36のzx−平面上では完全な半円とx軸で囲まれる領域となる。

【0041】上述のように電子が薄膜の高電位薄膜部分31の先端部からなんらかの効果によって放出されたとしても、負の勾配領域36においては、電子は下方（図z軸負の方向）の力を受けて落下する事が分かっている。さらに、様々な解析から、電子は高電位薄膜部31表面に落下し、一部は高電位薄膜31内に吸収され、素子電流として流れ、一部は、再び真空中へ散乱をおこなう事がわかってきた。そのように、電子は薄膜の高電位薄膜部分31の先端部で放出された後に、落下散乱を繰り返し、負の勾配領域を抜けきったものだけが引き上げ電極33に到達し、到達電流となる。

【0042】したがって、高電位薄膜部31および低電位薄膜部32のx方向の長さがx_sに比較して長い場合、上記で近似したように薄膜部を対向する電極平板と見なしてよく、また、亀裂の蛇行のスケールがx_sに比べて非常に小さければ、直線亀裂と見なして良い。

【0043】つまり、先に述べた、亀裂が直線とみなせる場合の表面伝導型電子放出素子を取り扱っているというのは上記の意味である。また上述の「考えている領域」というのは図6の34のように、電子のz方向の位置が素子表面からはかってx_sの数倍から10数倍程度の高さと、x方向には、淀み点の2から10倍程度の大きさをもつ、y方向に伸びた角柱の領域となる。つまり、1）亀裂部がx_sに比較して、その蛇行が小さいとき直線的であると見なせ、2）素子の電極および薄膜部の表面の凹凸がx_sに比較して著しく平坦であり、3）該角柱で囲まれる領域と比較して、高電位薄膜部及び低電位薄膜部が、十分大きい面積を持って広がっており、4）$H \gg x_s$、という状況が成り立っているとき、系は、式（1）あるいは、式（4）で記述される電界分布

似されるような電界分布は、引き上げ電極33に対応するような捕捉電極が等電位部31、32に対応する電極と同一基板上に形成されているものと著しくその性質を異にしている。また、素子にかかる電圧値が大きい場合、例えば、$V_f = 200$［V］の場合、$V_a = 1$［KV］、$H = 5$［mm］では、$x_s = 300$［μm］程度となり、上記（1）式あるいは式（4）で記述されるような素子を形成するためには、［mm］オーダーの素子を考える必要がある。従って、素子のかかる電圧値が大きくかつ素子の大きさがサブミリメータ以下の場合、上述の表面伝導型電子放出素子の特徴的な電界分布とは異なる電界分布を持つ事が容易に推測できる。

【0046】上述のように、静電的な系の特徴はほぼ記述したので、次に、電子の運動とこの系の静電的構造の関わり合いについてのべる。

【0047】エネルギー保存則より、素子外部（真空中）へ放出された電子のエネルギーは（$eV_f - W_f$）で与えられる。ここでeを電子の電荷として、W_fを高電位薄膜部31表面の平均的な仕事関係とする。V_fが数［V］から数10［V］であり、また、一般的な仕事関係が5［eV］前後であることから、電子は数［V］から数十［V］のエネルギーを持つ。数［eV］から数十［eV］程度のエネルギーを持つ電子は、高エネルギーの電子と異なる性質を持つ事は知られているが、その性質は詳しくわかってはいない。多くの考察から、高電位薄膜部31表面で弾性散乱がおこり、その弾性散乱成分の全体の割合をβとするとこれはほぼ0.1以上、0.5以下程度である事がわかってきている。また、エネルギーが低いための量子論的な波動的な振る舞いのためと、薄膜表面の凸凹のために、等方に散乱している成分がある事がわかっている。したがって、古典的には、ある方向に散乱される割合が、確率的に与えられているように解釈される。

【0048】このような散乱機構のために、電子の運動は統計的に扱うべきものである事が理解される。また、βの値が1以下である事から、真空中の電子は散乱を繰り返す度に、そのべき乗で減少していく事がわかる。

【0049】素子電流（I_f）分の引き上げ電極33への到達電子の電流量（I_e）を持って効率（$\eta = I_e / I_f$）とする際に、このような多重散乱は効率を低下させる方向にあると考えられる。したがって、効率を向上させる手段として、この電子の高電位薄膜部31表面へ

程度、何に比較して小さくするのかという事がここまでの説明において不明である。次に、電子のエネルギーから決定されるこの系の特徴的な長さについて述べる。これは、電子の運動から決定される長さである。

【0052】負の勾配領域内及び亀裂30近傍では、第1近傍として、回転電場として見なせるので、式（4）において、V_a＝0での回転電場に関する電子の運動を＊解析した。その結果、高電位薄膜部31上の点（x_0，0，0）で等方に射出した電子の高電位薄膜部31で落下点の分布のy方向の積分したものは、シミュレーションから、次の関数形でほぼあらわされられる事が判った。

【0053】

【数6】

式(6)

$$f(x)dx = \begin{cases} N g_0(x)dx & \text{for} \quad D/2 \le x < x_0 \\ \frac{N}{x}dx & \text{for} \quad x_0 \le x \le Cx_0 \\ 0 & \text{for} \quad Cx_0 < x \end{cases}$$

Nは規格化定数で、g_0は正の単調増加関数である。ここでCは、※

※【0054】

【数7】

式(7)

$$C = \exp\left(-5.6\left(\frac{eV_f}{W_f + eV_f}\right)^2 + 27.3\left(\frac{eV_f}{W_f + eV_f}\right) - 12.2\right)$$

として記述される倍率パラメータである。電子の軌道が射出位置の倍率でのみ決定されている事は、V_a＝0の際、この系に特徴的な長さが存在していない事を意味する。また、最大到達位置も、亀裂中央部から射出位置の倍数で決定されている。したがって、射出あるいは散乱された電子はほぼ射出された位置x_0に対して、最大

【0055】

【数8】

式(8)

$$Cx_0$$

のオーダーの（z方向正の）高さまで舞い上がると思ってよい。V_f＝14［V］、W_f＝5．0［eV］とすると、C＝130であり、x_0＝5［nm］とするとCx_0＝650［nm］程度である。

【0056】このように、電子の運動から決定される長さが判ったので、負の勾配領域36が何に比較してその大小が決定されるべきかが明らかになった。つまり、Cx_0を長さの単位として負の勾配領域36の大きさがあまり大きくない事が望まれる。

【0057】次に、亀裂の蛇行の効果について考察する。上記の考察から、単純化された電界（1）を更に近似すると式（4）のように変形できる。また、電子が散乱という確率論的な過程を経るために、電子の軌道の集

の要件を満たしている。）。したがって、実効的な亀裂幅Dが十分狭い（D＝0の）式（4）の電場が表面伝導電子放出素子を利用した電子放出装置の特徴的な電場であると理解してよい。従って、実効的な亀裂幅Dが十分狭い（D＝0の）高電位薄膜部31と低電位薄膜部32の素子部と引き上げ電極33によって形成される電場を考察する事が重要である。

【0058】また、亀裂が蛇行した際もx_0の最大と引き上げ電極33と素子の間の距離の比（x_0／H）は充分小さいと考えてよく（H≫x_0）、実効的な亀裂幅のない高電位薄膜部31と低電位薄膜部32の素子部のつくる電界と素子と引き上げ電極33の作る電界の線形和（重ね合せ）であると近似してよい。

【0059】従って、蛇行した亀裂の電界の本質的な部分は、実際の亀裂の幅が有限の幅を持っていたとしても、実効的な亀裂幅の十分狭い極限の（D＝0）素子部の電界分布である事が予想される。

【0060】蛇行しながら、かつ2次元平面上に存在する、亀裂幅の十分狭い（D＝0の）亀裂を持った素子部のつくる電位分布は、半空間上のグリーン関数の特徴により、低電位薄膜部32の電位をゼロとすると高電位薄膜部31をのぞむ立体角に比例する事が計算によって判る。従って、形状のある高電位薄膜部31の形状をAと

式（９）

$$V(x,y,z)=\frac{V_f}{2\pi}\Omega_A(x,y,z)+\frac{V_a}{H}z$$

となる（V_a＝０のとき、図７に示すように、電子の感じる電位は、高電位薄膜を望む立体角である。）。これを方向微分したものが電界となる。式（９）は亀裂の幅が有限であっても、実効的亀裂幅Ｄがx_sに比較して十分小さい場合は、良い近似で成り立つ事が上述の考察より判る。

【００６２】亀裂をｚ＝０のｘｙ－平面の（ｘ，ｙ，ｚ）＝（０，ｙ，０）とするｙ軸にとったとすると式（９）が式（５）に戻る事は容易に確認できる。

【００６３】負の勾配領域を小さくするという立場から、次に（９）式と負の勾配領域の関係について考察する。負の勾配領域は、電子放出素子がつくる回転電界の支配的領域であると理解できる。つまり、負の勾配領域の境界線上で、丁度回転電界のつくる電界のｚ方向の成分と引き上げ電極３３がつくる縦電界の釣り合っている事を意味し、更には、その内部では回転電界が支配的になるという事である。また、低電位薄膜部３２の電位をゼロとするとV_fの値の等電位線（面）は淀み点（線）から始まり、低電位薄膜部３２方向の充分大きいところでｘｙ－平面に平行になる。このV_fの等電位線（面）の内側（亀裂を含む側）を素子電位領域と呼ぶと、素子電位領域に、負の勾配領域が閉じ込められている事が容易に判る。この性質は、亀裂が直線か否かに寄らない。

【００６４】従って、この素子電位領域を小さくする事によって、負の勾配領域を小さくさせる事が可能である。実際、構成された電位の特徴的な場合を図８に図示した。（ａ）、（ｃ）が素子のモデルを上から見たものであり、３１，３２は対応する高電位薄膜部及び低電位薄膜部である。（ａ）の直線亀裂に対応する電位分布が（ｂ）に、（ｃ）の蛇行した亀裂の点線部断面の電位分布が（ｄ）に示してある。線で囲った負の勾配領域４０が小さくなっている事が判る。

【００６５】そこで、式（９）より、素子電位領域を小さくするためには、電子の軌道に対してその電子が臨む高電位薄膜部３１の面積を大きくしてやればよい事が結論付けされる。しかしながら、従来の表面伝導型電子放出素子においては、亀裂の蛇行が未制御でかつ、電子放出部の制御がなされていないために、この思想が活かさ

よって計算したものである。横軸が位置を表し、縦軸が効率である。また、横軸と平行に描いた直線は、直線亀裂の場合の計算結果である。亀裂の上方Cx_sにおいて、陽極の見渡せる立体角がπを越える箇所があれば、πよりも小さくなる箇所ができてしまう。この事実を反映して、図９（ｂ）に示すように効率はグラフのように、直線亀裂の場合の効率を越える箇所と越えていない箇所とが存在している。そのため、電子の放出する部分が亀裂にそって、全体に分布していると平均の電子到達率は直線のものとあまり変わらないものとなってしまう。また、図９（ａ）の亀裂の蛇行よりも小さい振幅、周期に関しては、上述の考察より、負の勾配の領域の直線の際のものからの差が実効的に小さくなり、図９（ａ）の負の勾配領域の形より直線の亀裂に対する負の勾配により近くなる。従って、小さな蛇行の効果は無視できる事は推測できる。実際、シミュレーションによって、数値実験を行うとそのような効果が得られた。

【００６７】つまり、上述のように、少なくも蛇行の振幅があまり大きくないときは、負の勾配領域を小さくする箇所が形成されても負の勾配領域が大きくなる箇所が同時にできてしまうために、単純な蛇行亀裂では、全体の電子到達率、更には効率を向上する事が不可能である事が結論付けられる。

【００６８】

【課題を解決するための手段】本発明の課題は、既に素子外部（真空中）に放出された電子が受ける電界の制御を行い、表面伝導型電子放出素子を流れる電流量と引き上げ電極に到達する電子の電流量との比であるところの効率を向上させる事である。この事は、物質中より電子を取り出すための電界の制御とはその目的が異なり、従ってこの課題を解決する手段は思想的にも全く異なったものであり、効果も全く異なっている事となる。

【００６９】上述のように効率を支配する要因のひとつとして負の勾配領域の大きさがあり、その大きさが形状に依存する事を示した。本発明ではこの負の勾配領域の制御を亀裂の形状の制御と電子放出部の位置の制御によって上記の課題を解決する。

【００７０】つまり、亀裂の高電位薄膜部側に凸になっ

きるかの設計指針を与え、構成したものが本発明である。表面伝導型電子放出素子においては、活性化という工程を経る事によって、亀裂に沿った電子を放出する部分を少なくとも数10［nm］から100［nm］の亀裂に沿った領域で平均してそれ以上の長さの測度で眺めると、平均化された電子放出する部分の分布は亀裂に沿ってほぼ連続的でかつ一様でかつ連続である事が知られている。この表面伝導型電子放出素子、特有の性質を利用すると、電子放出部を上記の意味で連続的に線分として設計、構成する事が可能である。この表面伝導型電子放出素子の著しい性質を利用する事により、引き上げ電極での電流量を減じる事なく、効率を向上させる設計方針を与え、構成したのが本発明である。

【0073】また、上述のように負の勾配領域を小さくさせるためには、その形状には幾つかのバリエーションが考えられるが、効率よくそれらを構成するために、本発明では周期的形状に限定している（この周期的形状をより一般の非周期形状に置き換える事は容易に可能である。）。

【0074】また、本発明等で述べる形状にはさまざまなものがあり、さまざまな形状パラメータを含んでいるが、基本的に形状は3つのパラメータ、周期lp、振幅laと電子の放出する部分の長さ（放出部長）leを共通の因子として持っている。本発明の典型的な形状に沿って、これら3つの形状パラメータの役割について解説する。

【0075】図10に本発明の典型的な例を図示した。この例に沿って、効率及び引き上げ電極での電流量Ieが上述のパラメータによってどのような変化をするかを述べる。その結果より、効果が顕在化するようなパラメータ領域を決定し、形状パラメータが該領域内になるように、亀裂形状を設計、制御する指針を与える。その指針に沿った制御亀裂によって、電流量Ieを減じる事なく、効率を向上させるという本発明の課題を解決する事が可能となることが判る。

【0076】図10の（a）は最も単純な本発明の形状図である。図に示すように、亀裂を人工的に制御して、90度の角と線分で構成された周期的な矩形形状にしてある。図中、太線38は電子放出部である。亀裂の38部分では、亀裂に沿った高電位薄膜部の先端から電子が放出するようにしている。その他の亀裂部分は、何らかの方法で電子が放出しないように設計されている。孤立

しながら、表面伝導型電子放出素子では、少なくとも100［nm］以上の解像度で見れば電子放出点が連続して存在しているため、電子放出部の長さを減ずると高電位薄膜部先端での電子の放出量がそれに伴って線形に減るので、図10の（b）に示すように電流量Ieはピークを持つ（Ieは効率と長さleの積に比例している。）。

【0078】同様に、他のパラメータを固定して、亀裂形状の周期lpを変化させた際の効率の依存性を見たのが図10の（c）図である。lpが大きくなる程効率が上昇する（単調増加である）事が判ると同時に、その依存性が収束する事がわかる。また、素子長W，を固定すると、周期を増やすという事は、全電子放出部長を短くする事と等価であるので、従って、lpを大きくする事は、現実の問題としては引き上げ電極での電流量Ieを小さくさせる要因となる（Ieはηにほぼ比例し、lpにほぼ反比例する。）。素子長W，を固定した際のleの依存性を図10（c）に示している。従って、lpにもle同様に目的とする効果に依存して、最適領域が存在する。

【0079】また、亀裂の振幅laと効率の関係は図10の（d）に示した。振幅は今考えている形状の場合は、電子放出部長と関係ないため、leのlp依存性は効率ηを通してのみ存在しており、Ieは効率ηに比例する。効率は、laの増加に伴い、単調に増加するが、これもまた、ある値に収束する。また、実際の素子を作る場合には、このlaはさまざまな理由から、有限の長さに留まる事が必要となり、やはり現実の問題としては最適値を持つ。

【0080】このように、ある種の形状（図10（a））の場合について考察したが、これらの結果は形状パラメータ、複雑に絡み合い、引き上げ電極の電位V，や、素子の電圧V，等によって、大きくその値を変える事がある。しかしながら、定性的な性質は上述したとおりである。

【0081】例えば、図11のような場合についても同様の考察が可能である。

【0082】そこで、通常考えられる条件に基いて検討した結果、本発明においては次のようなパラメータを選択するのが良いことがわかった。

【0083】5［μm］≦lp≦80［μm］

1［μm］≦le≦40［μm］

【００８５】しかしながら、振幅ｌａが十分長い場合はこの限りではない。図１２に示すように、制御された亀裂を構成し、該亀裂の全域で電子を放出させる事を考える。単位長さ当たりの電子の放出効率を効率密度と呼ぶと、効率密度の分布が亀裂の線素に沿って定義できる。このとき、振幅ｌａが大きくなると凸部での効率密度（図１２の３８部に相当する）は、ｌａに対して非線形に増加する。他方、凹部（図１２の３９部に相当）では、効率密度が非負関数である事から、下限を持つ事が判る。ｌａが小さいときには、両者はｌａ＝０での周りで線形化でき、亀裂にそった放出部に対して積分した積分値即ちこの系での（全）効率が、直線のものと変わらないというのが従来の表面伝導型電子放出素子での蛇行の効果である。

【００８６】しかしながら、ｌａを大きくすると、凸部での電子放出効率密度が大きくなり、全域にわたる積分値（全効率）が直線の際のものより大きくなる事がある。この事は形状に対して大きく依存する事であり、分布関数の積分として求められるものである（ある領域で、非常に効率密度が高い部分があったとしても、その測度が小さければ他の領域の効率密度が直線亀裂のものより大きく下回っていれば、全効率は直線亀裂のものよりも小さくなってしまう。）。しかしながら、数値実験及び実験によって、連続した電子放出部を持っている場合においても、図１１に示した程度の形状に対しては、電子放出効率を大きくする事が可能となることが判った。上述と同様にして検討した結果、好ましい範囲は下記のとおりである。なおｌｅは、ここでは絶縁領域の内、高電位側に張り出した部分の長さを示す。

【００８７】５［μｍ］≦ｌｐ≦８０［μｍ］
１［μｍ］≦ｌｅ≦２０［μｍ］
５［μｍ］≦ｌａ≦１００［μｍ］

従って、上記の設計思想に立って、本発明は以下のような制御された形状を持つ亀裂と制御された電子放出部を有する表面伝導型電子放出素子を用いた電子放出装置を提供する。

【００８８】すなわち本発明の第１の実施形態は、その一部に電子放出部を含む導電性薄膜を有する電子放出素子、及び電子を引き上げるための電極によって構成される電子放出装置において、該導電性薄膜を高電位側と低電位側とに分割するように、電気的に絶縁された、幅Ｄが条件、（ＶｆＨ／ＶａＤ）≫１、を満たす細長い領域

有することを特徴とすることを含む。

【００９０】本発明はまた、上記絶縁領域の１周期中に含まれる電子放出部の長さｌｅと該絶縁領域の周期ｌｐと該絶縁領域の高電位側に凸になった部分と、低電位側に凸になった部分の蛇行距離ｌａが、それぞれ次式の範囲にあることを特徴とする電子放出装置である。

【００９１】５μｍ≦ｌｐ≦８０μｍ
１μｍ≦ｌｅ≦４０μｍ
１μｍ≦ｌａ≦１００μｍ

本上記パラメータは、全体の電子放出率が、亀裂が直線の電子放出素子の効率の１．２倍以上となるように設定したものである。また、ｌａは、画素ピッチ等の要因により決められたものである。

【００９２】本発明は上記の条件に加え、その一部に電子放出部を含む導電性薄膜を有する上記電子放出素子が、さらに、対向する一対の素子電極を有し、該導電性薄膜の分割された上記高電位側と低電位側のそれぞれの部分が、上記素子電極のそれぞれの側に電気的に接続され、且つ該素子電極に挟まれた領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る周期的な形状を有し、上記導電性薄膜が上記素子電極に挟まれる領域の内、主に高電位側に凸になった部分に存在することを特徴とする電子放出装置を含む。

【００９３】本発明はさらに、上記電子放出素子が、表面伝導型電子放出素子であることを含む。

【００９４】本発明の第２の実施形態は、その一部に電子放出部を含む導電性薄膜を有する電子放出素子、及び電子を引き上げるための電極によって構成される電子放出装置において、該導電性薄膜を高電位側と低電位側とに分割するように、電気的に絶縁された細長い領域が該導電性薄膜に１本形成されており、該絶縁領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る概略周期的な形状を持ち、且つ、絶縁領域に連続的な線状の電子放出部が形成されており、且つ、該絶縁領域の１周期中に含まれる高電位側に凸になった部分の長さｌｅと該絶縁領域の周期ｌｐと該絶縁領域の高電位側に凸になった部分と、低電位側に凸になった部分の蛇行距離ｌａ及び引き上げ電極と低電位側の導電側の導電性膜との間の電位差Ｖａと引き上げ電極と上記電子放出素子の距離Ｈが、それぞれ次式の範囲にあることを特徴とする、電子放出装置である。

【００９５】５μｍ≦ｌｐ≦８０μｍ

含む導電性薄膜を有する上記電子放出素子が、さらに、対向する一対の素子電極を有し、該導電性薄膜の分割された上記高電位側と低電位側のそれぞれの部分が、上記素子電極のそれぞれの側に電気的に接続され、且つ該素子電極に挟まれた領域が高電位側に凸になった部分と、低電位側に凸になった部分とから成る周期的な形状を有し、上記導電性薄膜が上記素子電極に挟まれるように存在することを特徴とする、上記の電子放出装置を含む。

【００９７】本発明はさらに、上記電子放出部及びその近傍に、炭素及び／または炭素化合物を有することを含む。

【００９８】本発明はさらに、上記電子放出素子が、表面伝導型電子放出素子であることを特徴とする、電子放出装置である。

【００９９】本発明の第３の実施形態は上記の電子放出装置を構成するいずれかの電子放出素子が基体上に複数配置された電子源と電子を引き上げるための電極によって構成される電子放出装置である。

【０１００】本発明はさらに、上記電子源において、電子放出素子に電気的に接続された配線が、マトリクス状に形成されていることを含む。

【０１０１】本発明はさらに、上記電子源において、電子放出素子に電気的に接続された配線が、はしご状に形成されていることを含む。

【０１０２】本発明の第４の実施形態は、上記の電子放出装置の構成を有し、上記電子引き上げ電極が上記電子源から放出される電子源の照射により、発光して画像を形成する画像形成部材の機能を有する、画像形成装置である。

【０１０３】本発明の第５の実施形態は、本節の最初に記載の電子放出装置の製造方法であって、上記絶縁領域の内電子放出部以外の部分を、上記導電性薄膜を、集束イオンビーム法、レーザー加工法、ないしフォトリソグラフィー法のいずれかの微細加工技術により導電性薄膜の一部を除去することにより形成し、次いで該導電性薄膜に電圧を印加し電流を流すことにより、電子放出部を形成することを特徴とする、電子放出装置の製造方法である。

【０１０４】

【発明の実施の形態】

【０１０５】

【実施例】以下、実施例に基づいて本発明をさらに説明

中性洗剤、純水及び有機溶剤で洗浄した石英ガラス基板１に、真空蒸着法により厚さ５ｎｍのＴｉ、厚さ３０ｎｍのＰｔを順次積層した。つづいて、フォトレジスト（ＡＺ１３７０；ヘキスト社製）を塗布、ベークしてレジスト層を形成した後、フォトマスクを用いて露光、つづいて現像して素子電極２、３のレジストパターンを形成した後、ＰｔＴｉ膜の不要な部分をウェットエッチングして除去し、最後にレジストパターンを有機溶剤で除去して、素子電極２、３を形成した。素子電極の間隔Ｌ１は２０μｍ、電極長Ｗ２は３００μｍとした（図３（ａ））。

【０１０８】工程－ｂ

真空蒸着法により、厚さ５０ｎｍのＣｒ膜（不図示）を堆積、通常のフォトリソグラフィーの手法により、導電性薄膜の形状に対応する開口部を形成してＣｒマスクとした。

【０１０９】つづいて、有機Ｐｄ化合物の溶液（奥野製薬（株）；ＣＣＰ－４２３０）を塗布、大気中で３１０℃に加熱して焼成し、酸化パラジウム（ＰｄＯ）を主成分とする微粒子からなる薄膜を形成した。この後、ウェットエッチングによりＣｒマスクを除去、リフトオフにより所望のパターンを有する導電性薄膜７を形成した。導電性薄膜の抵抗値は、$Rs=4.0\times10^{4}$ Ω／□であった（図３（ｂ））。

【０１１０】工程－ｃ

上記素子を集束イオンビーム加工装置（ＦＩＢ）に設置し、導電性薄膜の所望の部分を、ＦＩＢによりスパッタリングして除去することにより、図１３（ａ）に示したような形状の絶縁領域を形成した。ここで、$le=5$μｍ、$lp=9$μｍ、$la=10$μｍとした。

【０１１１】なお、絶縁領域の幅は、高電位側に凸の部分（図１３（ａ）の太線で示した部分）で４０ｎｍ、他（図１３（ａ）の細線で示した部分）は１μｍとした。これは、高電位側に凸の部分のみを電子放出部とするためである。

【０１１２】工程－ｄ

図２の真空処理装置に、上記素子を設置し活性化処理を行った。ここで図２は従来例で示した図２６と同様の構成を有する。

【０１１３】真空ポンプ１５により真空装置１６を一旦高真空に排気した後、ｎ－ヘキサンを導入し、圧力を2.7×10^{-4}Ｐａとした。素子電極２、３の間にパル

なお、素子を走査電子顕微鏡により観察したところ、工程－ｄの後、上記電子放出部とその周辺に堆積物が観察された。これは、従来の表面伝導型電子放出素子についての知見に照らして炭素および／または炭素化合物と思われる。

（比較例１）実施例１の工程－ａ及び工程－ｂと同様な工程を行った後、次のような、通電フォーミング処理により、電子放出部を形成した。

【０１１５】工程－ｃ

素子を図２の真空処理装置に設置して、真空容器の内部を真空ポンプ１５により排気、圧力を２．０×10^{-3}Ｐａ以下までに減圧した。

【０１１６】つづいて、素子電極２と３の間にパルス電圧を印加した。パルス波形は三角波パルスで、パルス幅Ｔ１＝１ｍｓｅｃ、パルス間隔Ｔ２＝１０ｍｓｅｃとし、パルス波高値は０．１Ｖから始め、１Ｖ／ｍｉｎの＊

＊レートで漸増させた。波高値が５Ｖとなったとき、素子電流が急速に低下したためフォーミング処理を終了した。

【０１１７】この後、実施例１の工程－ｄ及び工程－ｅと同様の処理を行った。

【０１１８】上記実施例１及び比較例１の素子について、図２の装置により電子放出特性を測定した。その際、素子に印加したパルス電圧、パルス幅Ｔ１＝１００μｓｅｃ、パルス間隔Ｔ２＝１０ｍｓｅｃ、パルス波高値１７Ｖの矩形波パルスで、素子と引き上げ電極の距離Ｈは４ｍｍ、引き上げ電極の電位は１ｋＶとした。結果を表１に示す。なお、ηは電子放出効率（Ｉｅ／Ｉｆ）を示す。

【０１１９】

【表１】

表１

	Ｉｆ（ｍＡ）	Ｉｅ（μＡ）	η（％）
実施例１	１．２	２．９	０．２４
比較例１	２．０	２．２	０．１１

（比較例２）実施例１と同様に工程－ａおよびｂを行い、ＰｄＯ微粒子より成る導電性薄膜を形成する。つづいて、

工程－ｃ

集束イオンビーム装置により、直線状の絶縁領域を形成する。このとき、長さ５μｍの幅４０ｎｍの部分を幅１μｍの部分と交互に配置する。そのピッチは、９μｍである。すなわち、実施例１の素子のパラメータｌａを０とした場合に当たる。

【０１２０】以下同様にして、素子を作成し、特性を測定した。

【０１２１】結果は、Ｉｆ＝１．１ｍＡ、Ｉｅ＝１．１μＡ、η＝０．１０％となった。 ※

※【０１２２】（実施例２）絶縁領域の形状は、図１３（ａ）に示すもので、ｌｅ＝５μｍ、ｌｐ＝９μｍ、ｌａ＝５μｍとし、他は実施例１と同様の工程により作製した。

【０１２３】（実施例３）絶縁領域の形状は、図１３（ａ）に示すもので、ｌｅ＝５μｍ、ｌｐ＝９μｍ、ｌａ＝２μｍとし、他は実施例１と同様の工程により作製した。

【０１２４】上記素子の電子放出特性を実施例１と同様な方法により測定した。結果は表２に示す。

【０１２５】

【表２】

表２

	Ｉｆ（ｍＡ）	Ｉｅ（μＡ）	η（％）
実施例１	１．２	２．９	０．２４
実施例２	１．２	２．０	０．１７
実施例３	１．１	１．４	０．１３

（実施例４）絶縁領域の形状は、図１３（ａ）に示すもので、ｌｅ＝１０μｍ、l_p＝２４μｍ、ｌａ＝５μｍとし、他は実施例１と同様の工程により作製した。

【０１２６】（実施例５）絶縁領域の形状は、図１３

★り作製した。

【０１２７】実施例４、５の素子について、実施例１と同様の条件で電子放出特性を測定した結果、表３のようになった。

ｌｐ＝４μｍとした以外は、実施例と同じものを作成した。

［０１３０］（実施例７）本実施例でも、実施例１と同様の工程により作製した。ただし、工程－ｃにおける加工形状を、図１３（ｂ）に示したような形状とした。なお、絶縁領域の幅は、高電位側に凸の部分（図１３（ｂ）の太線で示した部分）で４０ｎｍ、他（図１３（ｂ）の細線で示した部分）は１μｍとした。これは、高電位側に凸の部分のみを電子放出部とするためである。

［０１３１］（実施例８）絶縁領域の形状は、図１３＊（ｃ）に示したものとした。作製工程は、実施例６と同一とした。

［０１３２］（実施例９）絶縁領域の形状は、図１３（ｄ）に示したものとした。作製工程は、実施例６と同一とした。

［０１３３］上記素子の電子放出特性を測定した。印加したパルス電圧の波高値は１７Ｖで、他の条件は実施例１と同様である。結果は表４に示す。

［０１３４］

［表４］

表４

	ｉｆ（ｍＡ）	ｉｅ（μＡ）	η（％）
実施例６	１．０	６．５	０．６５
実施例７	１．０	６．７	０．６７
実施例８	１．２	６．１	０．５１
実施例９	１．１	５．１	０．４６
比較例３	１．８	２．０	０．１１

（実施例１０）本実施例は、多数の電子放出素子を単純マトリクス配置した電子源の例である。電子源の一部の平面図を図１４に示す。また図中のＡ－Ａ′断面図を図１５に示す。

［０１３５］ここで、１は基板、７２はＸ方向配線（下配線とも呼ぶ）、７３はＹ方向配線（上配線とも呼ぶ）、２、３は素子電極、４、５は導電性薄膜、６１は層間絶縁層、６２は素子電極２と下配線７２の電気的接続のためのコンタクトホールである。

［０１３６］次に、製造方法を図１６及び図１７を使って工程順に具体的に説明する。なお、工程Ａ～Ｄは図１６の（ａ）～（ｄ）に対応し、各工程Ｅ～Ｈは図１７の（ａ）～（ｄ）に対応する。

［０１３７］工程－Ａ

清浄化した青板ガラス上に厚さ０．５μｍのシリコン酸化膜をスパッタ法で形成した基板１上に、真空蒸着法により、厚さ５ｎｍのＣｒ、厚さ６００ｎｍのＡｕを順次積層した後、ホトレジスト（ＡＺ１３７０、ヘキスト社製）をスピンナーにより回転塗布し、ベークした後、ホトマスク像を露光、現像して下配線７２を形成し、Ａｕ／Ｃｒ堆積膜をウェットエッチングして所望の形状の下配線７２を形成した。

［０１３８］工程－Ｂ

次に厚さ１．０μｍのシリコン酸化膜からなる、層間絶

［０１４０］工程－Ｄ

その後、素子電極２と素子電極ギャップＧとなるべきパターンをホトレジスト（ＲＤ－２０００Ｎ－４１、日立化成社製）で形成し、真空蒸着法により、厚さ５ｎｍのＴｉ、厚さ１００ｎｍのＮｉを順次堆積した。ホトレジストパターンを有機溶剤で溶解し、Ｎｉ／Ｔｉ堆積層をリフトオフし、素子電極間隔Ｌ１ ２０μｍ、電極長Ｗ２＝３００μｍの素子電極２、３を堆積した。

［０１４１］工程－Ｅ

素子電極２、３の上に上配線７３のホトレジストパターンを形成した後、厚さ５ｎｍのＴｉ、厚さ５００ｎｍのＡｕを順次真空蒸着により堆積し、リフトオフにより不要な部分を除去して、所望の形状の上配線７３を形成した。

［０１４２］工程－Ｆ

次に、膜厚３０ｎｍのＣｒ膜６３を真空蒸着により堆積、導電性薄膜７の形状の開口部を有するようにパターニングし、その上に有機Ｐｄ化合物の溶液（ｃｃｐ－４２３０：奥野製薬（株）製）をスピンナーにより回転塗布、３００℃１２分間の加熱焼成処理を施してＰｄＯ微粒子よりなる導電性薄膜７を形成した。この膜の膜厚は７０ｎｍであった。

［０１４３］工程－Ｇ

Ｃｒ膜６３をエッチャントを用いてウェットエッチング

だ。

【0145】工程－i

電子源基板をＦＩＢ加工装置に設置し、基板上の各電子放出素子の導電性薄膜に、実施例１と同様の絶縁領域を形成した。

【0146】このようにして作成した電子源を用いて画像形成装置を構成した例を、図１８を用いて説明する。

【0147】電子源基板７１をリアプレート８１上に固定した後、基板７１の５ｍｍ上方に、フェースプレート８６（ガラス基板８３の内面に蛍光膜８４とメタルバック８５が形成されて構成される）を支持枠８２を介して配置し、フェースプレート８６、支持枠８２、リアプレート８１の接合部にフリットガラスを塗布し、大気中で４００℃、約１０分間焼成することで封着した。またリアプレート８１への基板７１の固定もフリットガラスで行った。図１８において、７４は電子放出素子、７２、７３はそれぞれＸ方向及びＹ方向の素子配線である。

【0148】蛍光膜８４は、モノクロームの場合は蛍光体のみから成るが、本実施例では蛍光体はストライプ形状を採用し、先にブラックストライプを形成し、その間隙部に各色蛍光体を塗布し、蛍光膜８４を作製した。ブラックストライプの材料として通常良く用いられている黒鉛を主成分とする材料を用いた。ガラス基板８３に蛍光体を塗布する方法はスラリー法を用いた。

【0149】また、蛍光膜８４の内面側には通常メタルバック８５が設けられる。メタルバックは、蛍光膜作製後、蛍光膜の内面側表面の平滑処理（通常フィルミングと呼ばれる）を行い、その後、Ａｌを蒸着することで作製した。

【0150】フェースプレート８６には、さらに蛍光膜８４の導電性を高めるため、蛍光膜８４の外面側に透明電極（不図示）が設けられる場合もあるが、本実施例では、メタルバックのみで十分な導電性が得られたので省略した。

【0151】前述の封着を行う際、カラーの場合は各色蛍光体と電子放出素子とを対応させなくてはいけないため、十分な位置合わせを行った。

【0152】以上のようにして完成した画像表示装置のガラス容器内の雰囲気を排気管（図示せず）を通じ真空ポンプにて10^{-4}Ｐａ程度まで排気した後、ｎ－ヘキサンを導入、容器内の圧力を２．７×10^{-1}Ｐａとする。図１９に示すように、Ｙ方向配線を共通結線して１ライ

気し圧力を４．２×10^{-1}Ｐａまで下げた。

【0154】本実施例では、マトリクス状に配線した場合を示したが、はしご状の配線を用い、さらに変調用のグリッド電極を設けても同様の機能を有する装置が形成できる。

【0155】この後、マトリクス駆動により表示機能が正常に働き、特性が安定していることを確認してから、不図示の排気管をガスバーナーで熱することで封着し真空容器を封じきった。最後に封止後の真空度を維持するために、高周波加熱法でゲッター処理を行った。

【0156】以上のように完成した本発明の画像形成装置において、各電子放出素子には、容器外端子Ｄｘ１ないしＤｘｍ、Ｄｙ１ないしＤｙｎを通じ、走査信号及び変調信号を不図示の信号発生手段よりそれぞれ、印加することにより、電子放出させ、高圧端子Ｈｖを通じ、メタルバック８５、あるいは透明電極（不図示）に５．０ｋＶの高圧を印加し、電子ビームを加速し、蛍光膜８４に衝突させ、励起・発光させることで画像を表示した。

【0157】図２０は、実施例１０の画像形成装置（画像表示パネル）に、たとえばテレビジョン放送をはじめとする種々の画像情報源より供給される画像情報を表示できるように構成した表示装置の一例を示すための図である。図中１３０は画像表示パネル、１３１は画像表示パネルの駆動回路、１３２は画像表示パネルコントローラ、１３３はマルチプレクサ、１３４はデコーダ、１３５は入出力インターフェース回路、１３６はＣＰＵ、１３７は画像生成回路、１３８および１３９および１４０は画像メモリーインターフェース回路、１４１は画像入力インターフェース回路、１４２および１４３はＴＶ信号受信回路、１４４は入力部である（なお、本表示装置は、たとえテレビジョン信号のように映像情報と音声情報とを含む信号を受信する場合には、当然映像の表示と同時に音声を再生するものであるが、本発明の特徴と直接関係しない音声情報の受信、分離、再生、処理、記憶などに関する回路やスピーカーなどについては説明を省略する）。

【0158】以下、画像信号の流れに沿って各部の機能を説明してゆく。

【0159】まず、ＴＶ信号受信回路１４３は、たとえば電波や空間光通信などのような無線伝送系を用いて伝送されるＴＶ画像信号を受信するための回路である。受信するＴＶ信号の方式は特に限られるものではなく、た

は同軸ケーブルや光ファイバーなどのような有線伝送系を用いて伝送されるＴＶ画像信号を受信するための回路である。前記ＴＶ信号受信回路１４３と同様に、受信するＴＶ信号の方式は特に限られるものではなく、また本回路で受信されたＴＶ信号もデコーダ１３４に出力される。

【０１６１】また、画像入力インターフェース回路１４１は、たとえばＴＶカメラや画像読み取りスキャナーなどの画像入力装置から供給される画像信号を取り込むための回路で、取り込まれた画像信号はデコーダ１３４に出力される。

【０１６２】また、画像メモリーインターフェース回路１４０は、ビデオテープレコーダー（以下ＶＴＲと略す）に記録されている画像信号を取り込むための回路で、取り込まれた画像信号はデコーダ１３４に出力される。

【０１６３】また、画像メモリーインターフェース回路１３９は、ビデオディスクに記録されている画像信号を取り込むための回路で、取り込まれた画像信号はデコーダ１３４に出力される。

【０１６４】また、画像メモリーインターフェース回路１３８は、いわゆる静止画ディスクのように、静止画像データを記録している装置から画像信号を取り込むための回路で、取り込まれた静止画像データはデコーダ１３４に入力される。

【０１６５】また、入出力インターフェース回路１３５は、本表示装置と、外部のコンピュータもしくはコンピュータネットワークもしくはプリンターなどの出力装置とを接続するための回路である。画像データや文字・図形情報の入出力を行うのはもちろんのこと、場合によっては本表示装置の備えるＣＰＵ１３６と外部との間で制御信号や数値データの入出力などを行うことも可能である。

【０１６６】また、画像生成回路１３７は、前記入出力インターフェース回路１３５を介して外部から入力される画像データや文字・図形情報や、あるいはＣＰＵ１３６より出力される画像データや文字・図形情報にもとづき表示用画像データを生成するための回路である。本回路の内部には、たとえば画像データや文字・図形情報を蓄積するための書き換え可能メモリーや、文字コードに対応する画像パターンが記録されている読み出し専用メモリーや、画像処理を行うためのプロセッサーなどをは

置の動作制御や、表示画像の生成や選択や編集に関わる作業を行う。

【０１６９】たとえば、マルチプレクサ１３３に制御信号を出力し、画像表示パネルに表示する画像信号を適宜選択したり組み合わせたりする。また、その際には表示する画像信号に応じて画像表示パネルコントローラ１３２に対して制御信号を発生し、画面表示周波数や走査方法（たとえばインターレースかノンインターレースか）や一画面の走査線の数など表示装置の動作を適宜制御する。

【０１７０】また、前記画像生成回路１３７に対して画像データや文字・図形情報を直接出力したり、あるいは前記入出力インターフェース回路１３５を介して外部のコンピュータやメモリーをアクセスして画像データや文字・図形情報を入力する。

【０１７１】なお、ＣＰＵ１３６は、むろんこれ以外の目的の作業にも関るものであっても良い。たとえば、パーソナルコンピュータやワードプロセッサなどのように、情報を生成したり処理する機能に直接関ってもよい。あるいは、前述したように入出力インターフェース回路１３５を介して外部のコンピュータネットワークと接続し、たとえば数値計算などの作業を外部機器と共同して行ってもよい。

【０１７２】また、入力部１４４は、前記ＣＰＵ１３６に使用者が命令やプログラム、あるいはデータなどを入力するためのものであり、たとえばキーボードやマウスのほか、ジョイスティック、バーコードリーダー、音声認識装置など多様な入力機器を用いることが可能である。

【０１７３】また、デコーダ１３４は、前記画像生成回路１３７ないしＴＶ信号受信回路１４３より入力される種々の画像信号を３原色信号、または輝度信号とＩ信号、Ｑ信号に逆変換するための回路である。なお、同図中に点線で示すように、デコーダ１３４は内部に画像メモリーを備えるのが望ましい。これは、たとえばＭＵＳＥ方式をはじめとして、逆変換するに際して画像メモリーを必要とするようなテレビ信号を扱うためである。また、画像メモリーを備えることにより、静止画の表示が容易になる、あるいは前記画像生成回路１３７およびＣＰＵ１３６と共同して画像の間引き、補間、拡大、縮小、合成をはじめとする画像処理や編集が容易に行えるようになるという利点が生まれるからである。

って異なる画像を表示することも可能である。また、画像表示パネルコントローラ132は、前記CPU136より入力される制御信号にもとづき駆動回路131の動作を制御するための回路である。

【0175】まず、画像表示パネルの基本的な動作に関るものとして、たとえば画像表示パネルの駆動用電源（図示せず）の同さシーケンスを制御するための信号を駆動回路131に対して出力する。

【0176】また、画像表示パネルの駆動方法に関るものとして、たとえば画像表示周波数や走査方法（たとえばインターレースかノンインターレースか）を制御するための信号を駆動回路HH131に対して出力する。

【0177】また、場合によっては表示画像の輝度やコントラストや色調やシャープネスといった画質の調整に関る制御信号を駆動回路131に対して出力する場合もある。

【0178】また、駆動回路131は、画像表示パネル130に印加する駆動信号を発生するための回路であり、前記マルチプレクサ133から入力される画像信号と、前記画像表示パネルコントローラ132より入力される制御信号に基づいて動作するものである。

【0179】以上、各部の機能を説明したが、図20に例示した構成により、本表示装置においては多様な画像情報源より入力される画像情報を画像表示パネル130に表示することが可能である。すなわち、テレビジョン放送をはじめとする各種の画像信号はデコーダ134において逆変換された後、マルチプレクサ133において適宜選択され、駆動回路131に入力される。一方、画像表示パネルコントローラ132は、表示する画像信号に応じて駆動回路131の動作を制御するための制御信号を発生する。駆動回路131は、上記画像信号と制御信号にもとづいて画像表示パネル130に駆動信号を印加する。これにより、画像表示パネル130において画像が表示される。これらの一連の動作は、CPU136により総括的に制御される。

【0180】また、本表示装置においては、前記デコーダ134に内蔵する画像メモリや、画像生成回路137および情報の中から選択したものを表示するだけでなく、表示する画像情報に対して、たとえば拡大、縮小、回転、移動、エッジ強調、間引き、補間、色変換、画像の縦横比変換などをはじめとする画像処理や、合成、消去、接続、入れ換え、はめ込みなどをはじめとする願図[illegible]ゲーム機などの機能を一台で兼ね備えることが可能で、産業用あるいは民生用として極めて応用範囲が広い。

【0182】なお、上記図20は、電子放出素子を電子ビーム源とする画像表示パネルを用いた表示装置の構成の一例を示したに過ぎず、これのみに限定されるものでないことは言うまでもない。たとえば、図20の構成要素のうち使用目的上必要のない機能に関る回路は省いてもさしつかえない。またこれとは逆に、使用目的によってはさらに構成要素を追加してもよい。たとえば、本表示装置をテレビ電話機として応用する場合には、テレビカメラ、音声マイク、照明器、モデムを含む送受信回路などを構成要素に追加するのが好適である。

【0183】（実施例11）前記実施例10と同様な工程をもって、画像形成装置を作製した。ただし、工程－1において形成する絶縁領域の形状は、実施例7と同様とした。

【0184】その結果、実施例10同様に、良好な画像表示装置を得ることができた。

【0185】（実施例12）本実施例の電子放出素子は、図21に示したのと同様な構成を有する。図21（a）は平面図、図21（b）は断面図である。1は基板、1202、1203は素子電極、1204、1205は導電性薄膜、1206は亀裂すなわち電子放出部である。ここで電極のギャップ幅Gは一定になるように採られている。なお電極ギャップの中心線に沿って1e、1p、1aを定義することにする。ただし本実施例は後述するようにフォーミングにより亀裂1206を形成しているので、亀裂1206は必ずしも中心線に沿って形成されているわけではないし、各パターン毎の亀裂1206の形状は全く同一であるわけではない。

【0186】図22及び図3を用いて本実施例の電子放出素子の製造方法を説明する。製造方法の大筋は、従来の技術で述べた特開平7－235255号公報とほぼ同様である。従来の技術で述べた内容と異なっている部分を以下に詳しく述べる。

【0187】工程－a

図22（a）に示す形状を持つ素子電極1202、1203を、従来の技術で述べたのと同様な方法で、Ni（100nm）／Ti（5nm）堆積膜にて、シリコン酸化膜（0.5μm）／青板ガラスからなる基板1上にリフトオフ法にて形成した。なお本実施例では、Ie＝10μm、Ip＝20μm、I_s＝50μm、G＝5μ[illegible]

従来の技術で述べたのと同様な方法（フォーミング処理）により、図22（c）に示すように導電性薄膜7の一部に亀裂1206を形成した。

【0190】なお本実施例では三角波を用い、電圧波形のパルス幅T1を1msec、パルス間隔T2を10msecとし、三角波の波高値（フォーミング時のピーク電圧）は0.1Vステップで除々に昇圧し、フォーミング処理を行った。またフォーミング終了時の電圧は5Vであった。

【0191】工程－e

従来の技術で述べたのと同様な方法（活性化処理）により、活性化処理前には0であった素子電流If及び放出電流Ieが著しく変化して増加するようになり、亀裂1206に電子放出部が形成された。

【0192】なお本実施例では矩形波を用い、電圧波形のパルス幅T1を1msec、パルス幅T2を10msecとし、矩形波の波高値（活性化時のピーク電圧）は15Vとし、活性化処理はロータリーポンプで真空排気した約1.3×10^{-1}Paの真空雰囲気下で60分間行った。

【0193】以上のようにして作製された素子について、その電子放出特性を図2の構成の測定評価装置により測定した。なお本実施例では、引き上げ電極と電子放出素子間の距離を4mm、引き上げ電極の電位を1kV、電子放出特性測定時の真空装置内の真空度を1.3×10^{-4}Paとした。

【0194】以上のような測定評価装置を用いて、本電子放出素子の素子電極1202及び1203の間に素子電圧を印加し、その時に流れる素子電流If及び放出電流Ieを測定したところ、図4に示したような電流－電圧特性が得られた。本素子では、素子電圧7V程度から急激に放出電流Ieが増加し、素子電圧14Vで素子電流Ifが1.2mA、放出電流Ieが3.6μAとなり、電子放出効率η＝Ie／If（%）は0.3%であった。

【0195】また本電子放出素子は従来の技術で述べたのと同様な電子放出特性を示しているので、特開平7－235255号公報に述べているように、多数の電子放出素子をマトリクス状に配置することによって、同様にして画像表示装置として構成することができる。

【0196】同様にして得られた画像表示装置は、本発明の電子放出装置の特性を備えた、従来の電子放出装置

【0199】工程－c'

バブルジェット方式のインクジェット装置151によって、上記の暗赤色溶液の液滴152を素子電極1202、1203を形成した基板1の上に素子電極1202、1203の一部にまたがるように付与した（図23の（a））。ここで153は基板1に付与された液滴である。次に80℃で2分乾燥させた。次に350℃で12分焼成して主として酸化パラジウムからなる導電性薄膜7を形成した（図23の（b））。なお本実施例では、導電性薄膜7のへりと素子電極1202のへりを結ぶ距離Pの平均値は17.5μmであった。

【0200】実施例12と同様な方法で電子放出特性を評価したところ、素子電圧14Vでは素子電流Ifが1.0mA、放出電流Ieが2.8μAとなり、電子放出効率η＝Ie／If（%）は0.28%であった。

【0201】（実施例14）実施例12において、Ie＝5μm、Ip＝20μm、Ia＝50μmとした以外は、同様にして電子放出素子を作製した。

【0202】実施例12と同様な方法で電子放出特性を評価したところ、素子電圧14Vでは素子電流Ifが1.2mA、放出電流Ieが6.0μAとなり、電子放出効率η＝Ie／If（%）は0.50%であった。

【0203】（実施例15）Ie＝5μm、Ip＝20μm、Ia＝50μmとした以外は、実施例13と同様な電子放出素子を作製した。

【0204】実施例12と同様な方法で電子放出特性を評価したところ、素子電圧14Vでは素子電流Ifが1.0mA、放出電流Ieが4.5μAとなり、電子放出効率η＝Ie／If（%）は0.45%であった。

【0205】（実施例16）本実施例の電子放出素子は、図24（a）に示したのと同様の構成を有する。1は基板、2、3は素子電極、7は導電性薄膜、1606は亀裂すなわち電子放出部である。なおIe＝S1－S2、Ip＝S1＋S3、Ia＝T1で定義することにする。ただし本実施例は後述するようにフォーミングにより亀裂1606を形成しているので、亀裂1606は必ずしも直線状に形成されているわけではないし、各パターン毎の亀裂1606の形状は全く同一であるわけではない。

【0206】図3、図24（a）を用いて本実施例の電子放出素子の製造方法を説明する。

【0207】工程－（1）

除去して、素子電極2、3を形成した。素子電極の間隔L1は10μm、電極長W2は100μmとした（図3（a））。

【0208】工程－（2）
真空蒸着法により、厚さ50nmのCr膜（不図示）を堆積、通常のフォトリソグラフィーの手法により、導電性薄膜の形状に対応する開口部を形成してCrマスクとした。

【0209】つづいて、酢酸パラジウムモノエタノールアミン（以下PAME）をスピンナーにより回転塗布、大気中で310℃に加熱して焼成し、酸化パラジウム（PdO）を主成分とする微粒子からなる薄膜を形成した。この後、ウェットエッチングによりCrマスクを除去、リフトオフにより所望のパターンを有する導電性薄膜7を形成した。導電性薄膜の抵抗値は、Rs＝4.0×10^4 Ω/□であった（図3（b））。

【0210】工程－（3）
上記素子をx、y駆動パルスモーター付きのステージ上に配し、Arイオンレーザーの励起波長514.5nmの発振線を用い、導電性薄膜上で10mWになるように上記レーザーを照射し、x、yステージを移動させることで、金属Pd部分を除去し、図24（a）に示したような形状の絶縁領域を形成した。絶縁領域の幅は、S1＝5μm、S2＝1μm、S3＝5μm、T1＝7μmとした。したがってle＝3μm、lp＝10μm、la＝7μmと定義される。

【0211】工程－（4）
次に、この素子を図2の測定評価装置に設置し、真空ポンプにて排気して2.0×10^{-3}Paの圧力に達した後、素子に素子電圧Vfを印加するための電源10より素子電極2、3間にそれぞれパルス電圧を印加し、通電処理（フォーミング処理）を施すことにより亀裂1606を形成した。

【0212】素子電流Ifが十分小さくなった後、電圧印加を終了し、水素雰囲気下で1時間放置し、導電性薄膜7を完全に金属Pdのみからなるように、還元処理を施した。

【0213】工程－（5）
＊次に、再び真空ポンプ15により真空装置16を排気し、圧力を2.0×10^{-3}Paとした。この後、素子に素子電圧Vfを印加するための電源10より素子電極2、3間にパルス電圧を印加して素子電流Ifを測定しながら活性化処理を行った。活性化処理前には実質的に0であった素子電流Ifが著しく変化して増加するようになり、約30分で素子電流Ifが飽和したので処理を終了した。用いたパルスは、矩形波パルスで、パルス幅T1＝0.5msec、パルス間隔T2＝10msec、波高値は16Vである。

【0214】工程－（6）
排気装置をイオンポンプに切り替え、真空装置16全体を200℃程度に加熱しながら排気した。圧力は24時間後に1.3×10^{-5}Paまで低下した。上述の工程で作製した表面伝導型電子放出素子の特性を把握するために、素子の電子放出特性を上述の図2の評価装置を用いて行った。

【0215】（比較例4）実施例1の工程－（1）及び工程－（2）と同様な工程を行った後、工程－（3）を行わず、工程－（4）～工程－（6）の工程を施すことにより、電子放出部を形成した。

【0216】工程－（7）
上記実施例16及び比較例2で作製した表面伝導型電子放出素子の特性を把握するために、図2の評価装置により電子放出特性を測定した。これらの電子放出素子及び引き上げ電極12は真空装置16内に設置されており、その真空装置には不図示の高真空を形成するための排気ポンプ及び真空系等の真空装置に必要な機器が具備されており、所望の真空下で本素子の測定評価を行えるようになっている。尚、素子には、3側にパルス波高値15Vの矩形波パルス電圧を印加し、印加したパルス電圧は、パルス幅T1＝0.1msec、パルス間隔T2＝25msecで、素子と引き上げ電極の距離Hは4mm、引き上げ電極の電位は1kV、電子放出特性時の圧力を2.0×10^{-5}Paとした。結果を表5に示す。なお、ηは電子放出効率（Ie／If）を示す。

【0217】
【表5】
＊

表5

	If（mA）	Ie（μA）	η（%）
実施例16	1.1	5.1	0.46
比較例4	2.5	2.5	0.10

6内を一旦高真空に排気し、アセトンを導入し、圧力を2．5×10^{-3}Paとした。素子電極2と3の間にパルス電圧を印加して活性化処理を行った。用いたパルスは矩形波パルスで、パルス幅T1＝1msec、パルス間隔T2＝10msec、波高値は10Vから0．2V／minのレートで18Vまで漸増させた。

【0222】工程－（5）

アセトンの導入をやめ、真空装置16全体を200℃程度に加熱しながら排気装置115により排気した。圧力は24時間後に1．3×10^{-7}Paまで低下した。本実施例の工程で作製した、表面伝導型電子放出素子の特性を把握するために、実施例1と同様の図2の評価装置により電子放出特性を測定した。素子に印加したパルス電圧は実施例1と同様である。電子放出特性時の圧力は2．0×10^{-7}Paとした。

【0223】本実施例で作製した素子は、素子電圧10V程度から急激に放出電流Ieが増加し、素子電圧15Vでは、素子電流Ifが1．1mA、放出電流Ieが6．4μAとなり、電子放出効率ηは0．58%であった。

【0224】（実施例18）実施例16の工程－（3）において、集束イオンビームを用いた点以外はその他の工程は実施例16とまったく同様の処理を施した。最終的に図2の評価装置により、圧力は2．0×10^{-7}Paとし、実施例16と同条件で電子放出特性を測定したところ、素子電圧15Vでは、素子電流Ifが1．0mA、放出電流Ieが5．1μAとなり、電子放出効率ηは0．51%であった。

【0225】（実施例19）実施例16の工程－（3）において、使用したレーザーをNd：YAGレーザーとした点以外はその他の工程は実施例16とまったく同様の処理を施した。最終的に図2の評価装置により、圧力は2．0×10^{-7}Paとし、実施例16と同条件で電子放出特性を測定したところ、素子電圧15Vでは、素子電流Ifが1．3mA、放出電流Ieが5．1μAとなり、電子放出効率ηは0．40%であった。

【0226】（実施例20）実施例16の工程－（2）において、通常のフォトリソグラフィーの手法を適用し、リフトオフ後のパターンが図24（a）となるようにして、導電性薄膜7の形成、並びに絶縁領域の形成を同時に行った。その他は実施例16とまったく同様の処理を施した。最終的に図2の評価装置により、圧力は

【0228】（実施例21）前記実施例10における工程Iを、下記の工程i′に変更した以外は、実施例10と同様にして画像形成装置を作製した。

【0229】工程－i′

電子源基板をx、y駆動パルスモーター付きのステージ上に配し、Arイオンレーザーの励起波長514．5nmの発振線を用い、導電性薄膜上で10mWになるように上記レーザーを照射し、x、yステージを移動させることで、金属Pd部分を除去し、実施例17と同様の絶縁領域を形成した。

【0230】次に、この素子を図2の測定評価装置に設置し、真空ポンプにて排気して2．0×10^{-7}Paの圧力に達した後、素子に素子電圧Vfを印加するための電源10より素子電極2、3間にそれぞれパルス電圧を印加し、通電処理（フォーミング処理）を施すことにより亀裂6を形成した。

【0231】完全に素子電流ifが0になった後、電圧印加を終了し、水素雰囲気下で1時間放置し、導電性薄膜7を完全に金属Pdのみからなるように、還元処理を施した。

【0232】その結果、実施例10同様に、良好な画像表示装置を得ることができた。

【0233】（実施例22）本実施例では、絶縁領域全体に、連続した電子放出部が形成されている場合の例を説明する。

【0234】本実施例では、実施例1と同様にして、電子放出素子を作製した。ただし、工程－cにおいて、集束イオンビーム加工装置によって形成した絶縁領域は、図13（a）に示した形状とし、且つ、該絶縁領域の幅は全て（太線及び細線の部分）を40nmとなるように調整した。なお、ie＝5μm、ip＝10μm、ia＝10μmとした。

【0235】上記実施例の素子について、図2の装置により電子放出特性を測定した。その際、素子に印加したパルス電圧は、パルス幅T1＝100μsec、パルス間隔T2＝10msec、パルス波高値15Vの矩形波パルスで、素子と引き上げ電極の距離Hは4mm、引き上げ電極の電位は1kVとした。その結果、素子電流if＝2．5mA、放出電流Ie＝5．2μA、電子放出効率η＝0．21%が得られた。

【0236】

【発明の効果】以上に説明したように、本発明により、

放出装置の説明図。

【図３】本発明の表面伝導型電子放出素子の製造方法を説明する図。

【図４】本発明の表面伝導型電子放出素子を用いた電子放出装置の電流特性図。

【図５】従来の表面伝導型電子放出素子を用いた電子放出装置の特徴的な電位分布図。

【図６】従来の表面伝導型電子放出素子を用いた電子放出装置の特徴的な電位分布図。

【図７】平面内に存在する２値化された電位指定境界に対する電位分布の説明図。

【図８】直線亀裂と蛇行亀裂をもつ表面伝導型電子放出素子を用いた電子放出装置の特徴的な電位分布図。

【図９】従来の素子における蛇行の効果の説明図。

【図１０】制御された蛇行のパラメータ依存性を示す図。

【図１１】特別な蛇行の例を示す図。

【図１２】制御された蛇行の！ａ依存性を示す図。

【図１３】本発明の表面伝導型電子放出素子の一例を示す図。

【図１４】本発明のマトリクス配列の電子源の構成を示す部分平面図。

【図１５】図１４のＡ－Ａ′に沿った断面の構成を示す図。

【図１６】本発明のマトリクス配列の電子源の製造工程を説明するための図。

【図１７】本発明のマトリクス配列の電子源の製造工程を説明するための図。

【図１８】本発明のマトリクス配列の電子源を用いた画像形成装置の構成を示す図。

【図１９】本発明のマトリクス配列の電子源及び画像形成装置の製造の際の、活性化処理のための配線を示す模式図。

【図２０】本発明の画像形成装置を用いた画像表示システムの一例を示すブロック図。

【図２１】本発明の表面伝導型電子放出素子の一例を説明する図。

【図２２】本発明の表面伝導型電子放出素子の製造方法の一例を説明する図。

【図２３】本発明の表面伝導型電子放出素子の製造方法の一例を説明する図。

【図２４】本発明の表面伝導型電子放出素子の一例を説明する図。

子放出装置の電流特性図。

【符号の説明】

１　基板
２，３　素子電極
４，５，７　導電性薄膜
６　亀裂
１０　電源
１２　引き上げ電極
１１，１４　電流計
１３　高圧電源
１５　真空ポンプ
１６　真空容器
３０　亀裂
３１　高電位薄膜部
３２　低電位薄膜部
３３　引き上げ電極
３４　考えている領域
３５　淀み点
３６　従来の素子の負の勾配領域
３８　凸部
３９　凹部
４０　本発明の素子の負の勾配領域
６１　層間絶縁層
６２　コンタクトホール
６３　Ｃｒ膜
６５　電源
６６　電流測定用抵抗
６７　オシロスコープ
６８　共通電極
７１　基板
７２　Ｘ方向配線
７３　Ｙ方向配線
７４　電子放出素子
８１　リアプレート
８２　支持枠
８３　ガラス基板
８４　蛍光膜
８５　メタルバック
８６　フェースプレート
１３０　画像表示パネル
１３１　駆動回路
１３２　画像表示パネルコントローラー
１３３　[illegible]

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１４２、１４３　ＴＶ信号受信回路
１４４　入力部
１５１　インクジェット装置
１５２　液滴
１５３　基板に付与された液滴
１２０２、１２０３　素子電極

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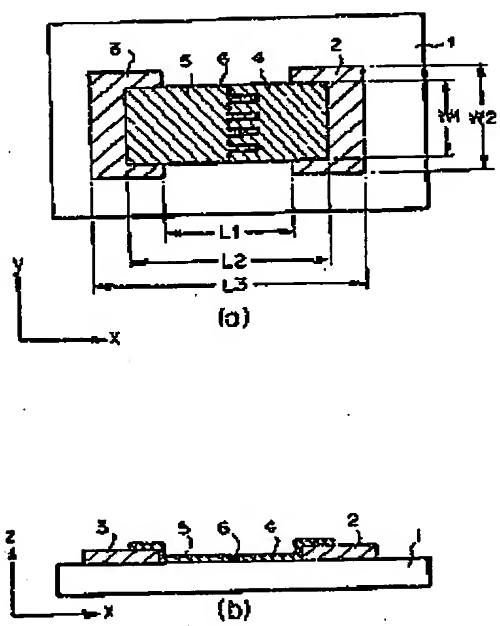
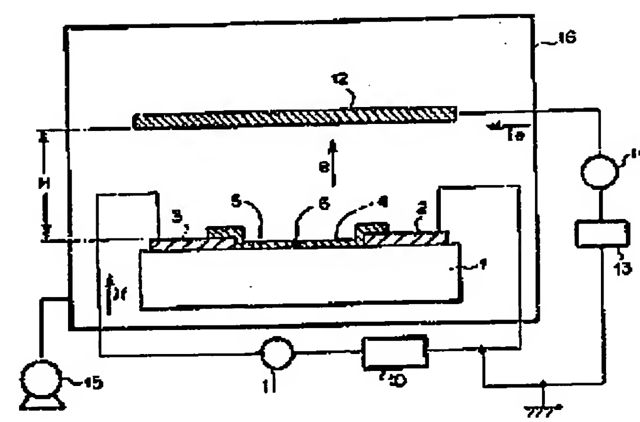
＊１２０４、１２０５　導電性薄膜
１２０６　亀裂
１６０６　亀裂
５００４、５００５　導電性薄膜
５００６　亀裂

＊

【図１】



【図２】



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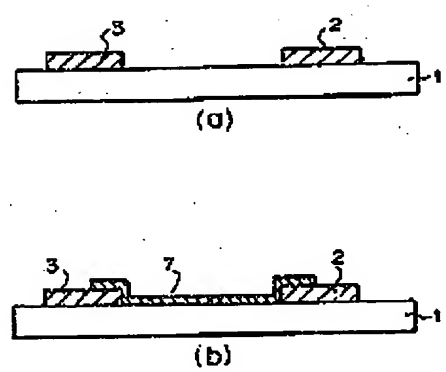

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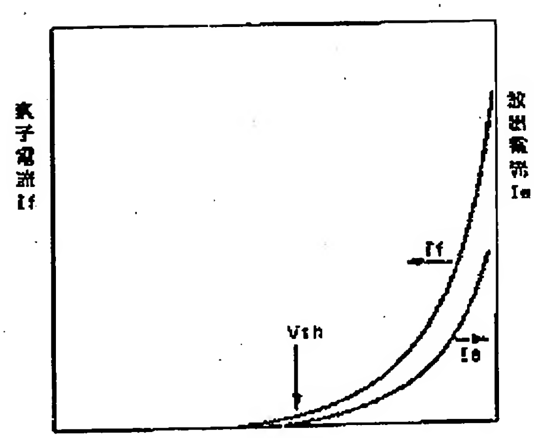

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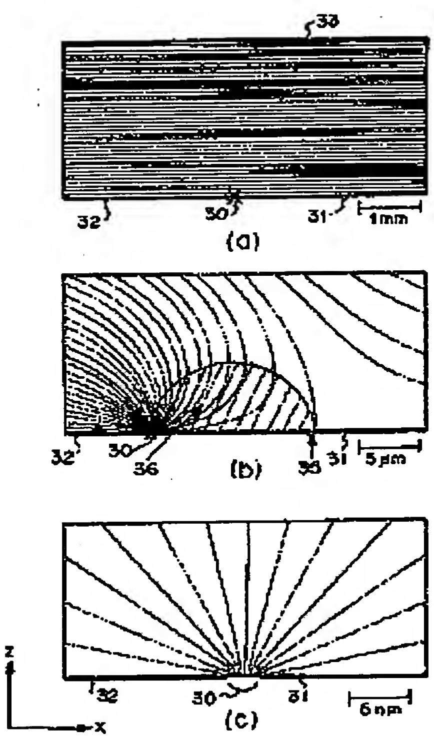
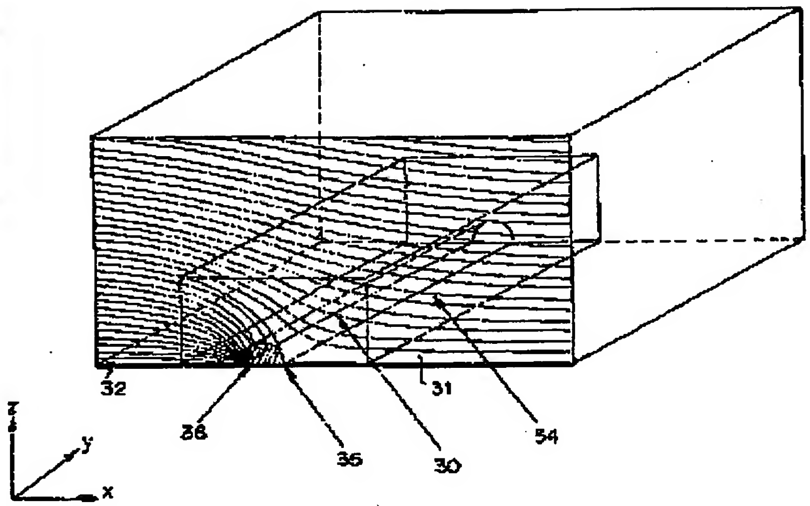
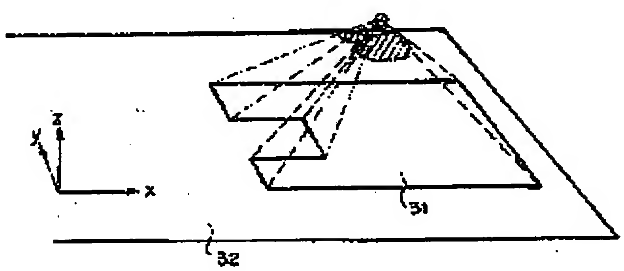


【図6】



【図7】



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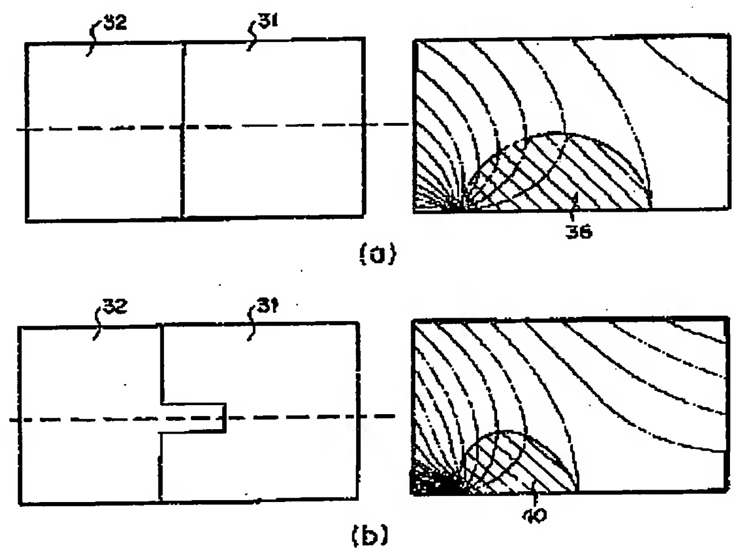
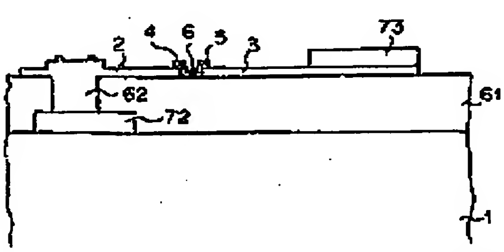
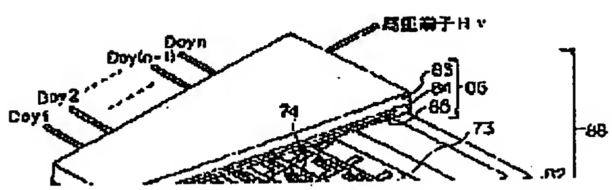


【図15】



【図18】



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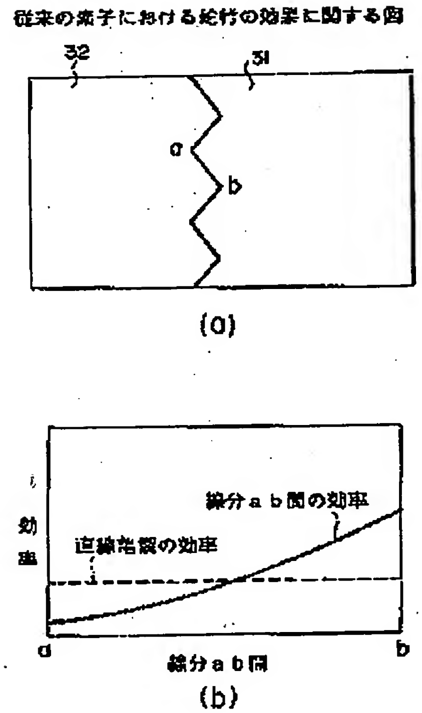
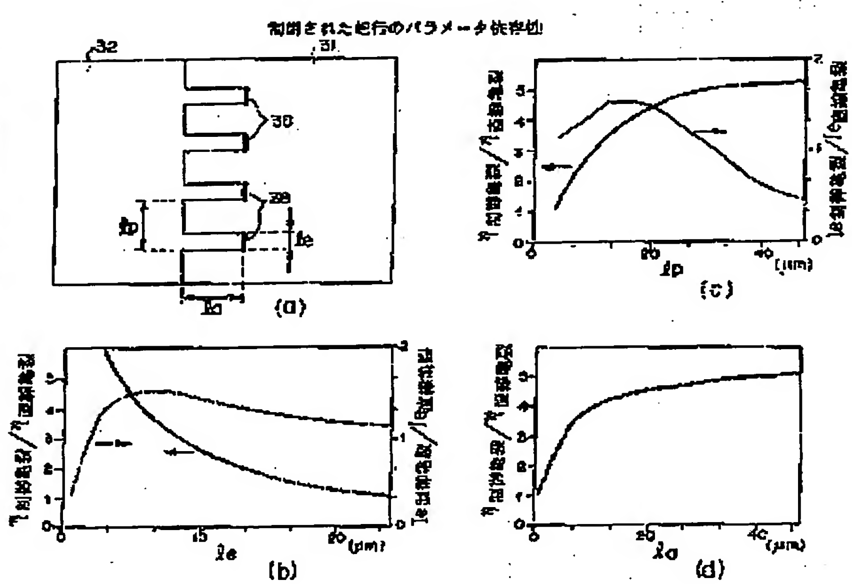


【図10】



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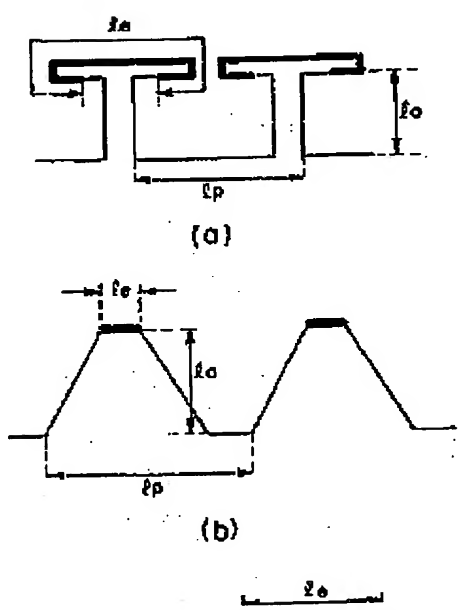
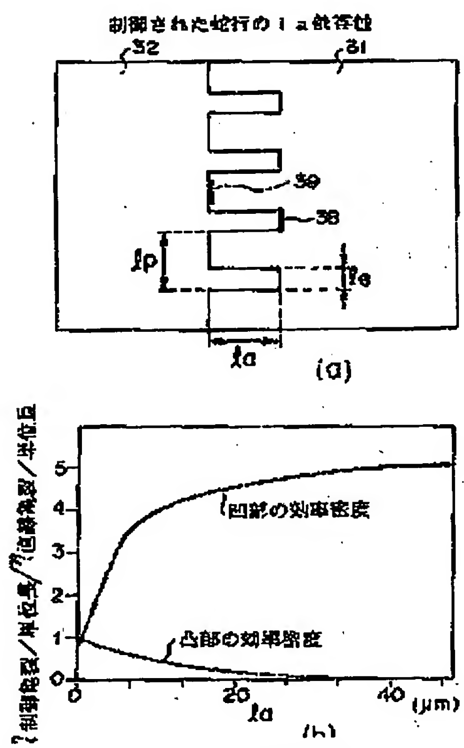
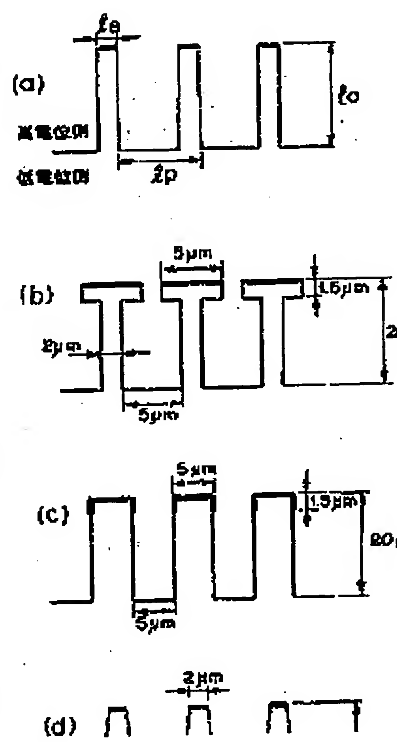


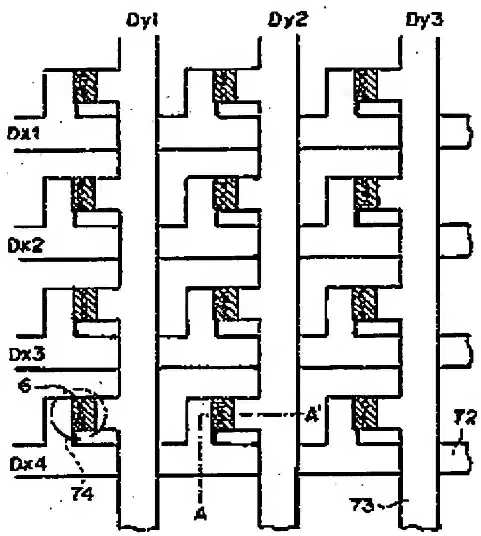
【図12】



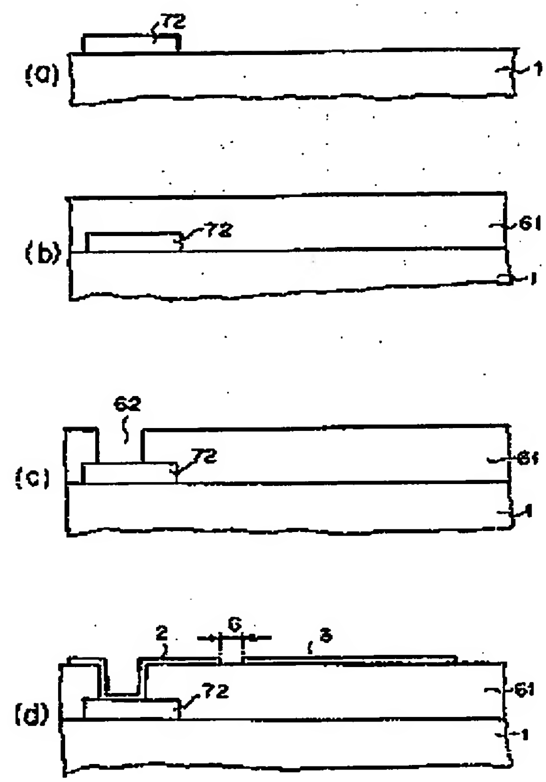
【図13】



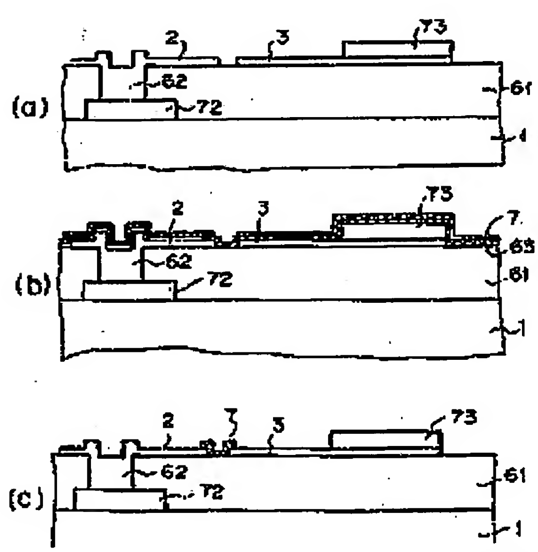
【図１４】



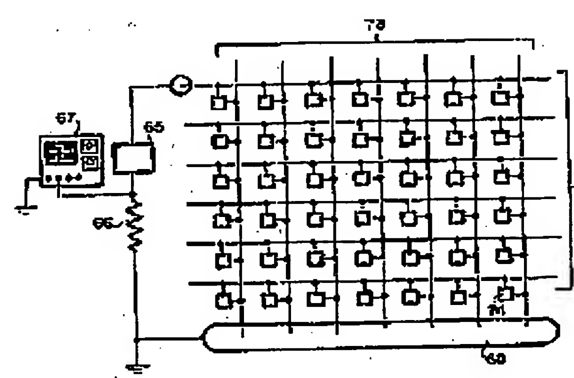
【図１６】



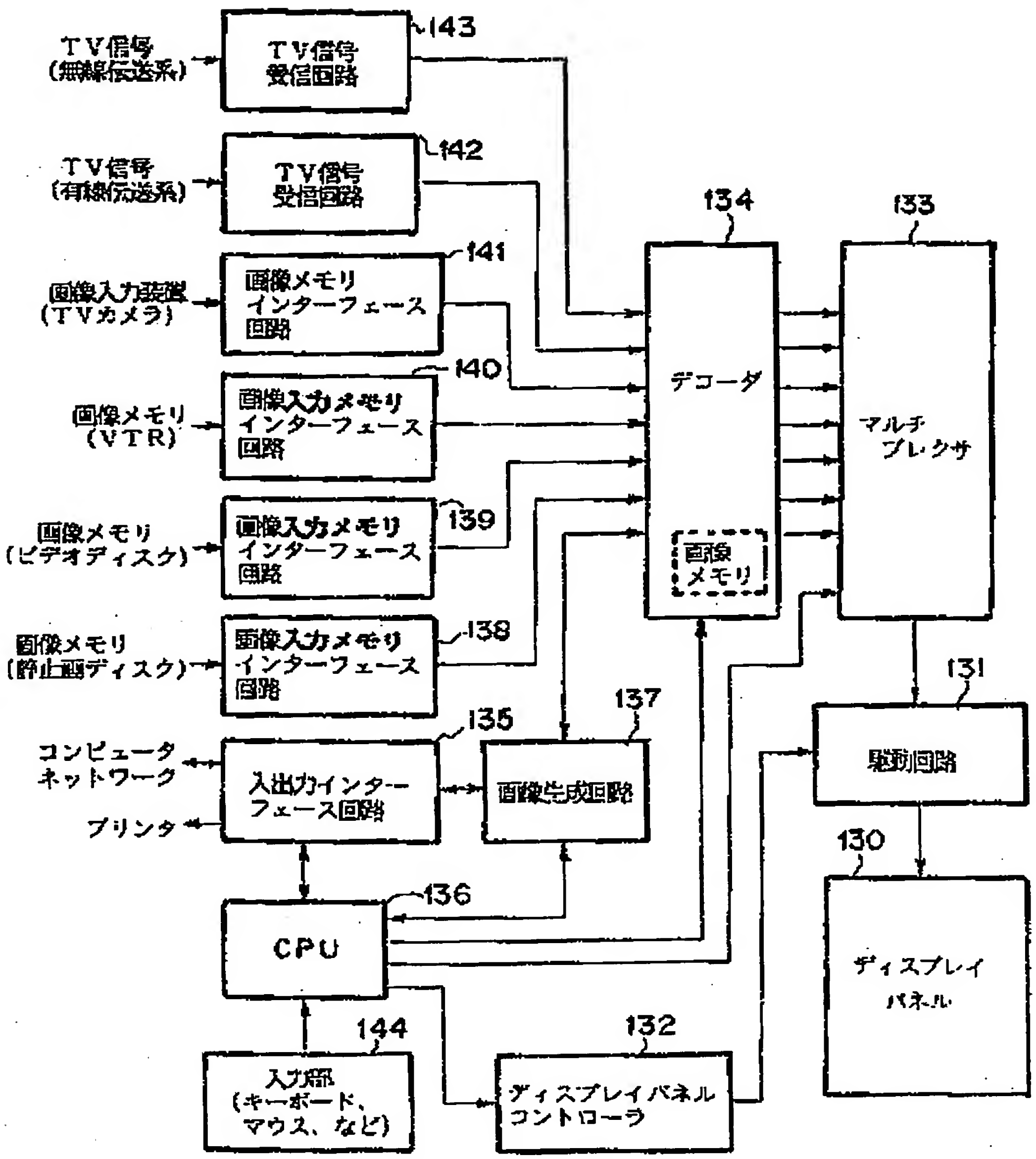
【図１７】



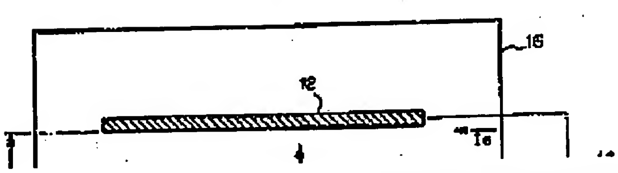
【図１９】



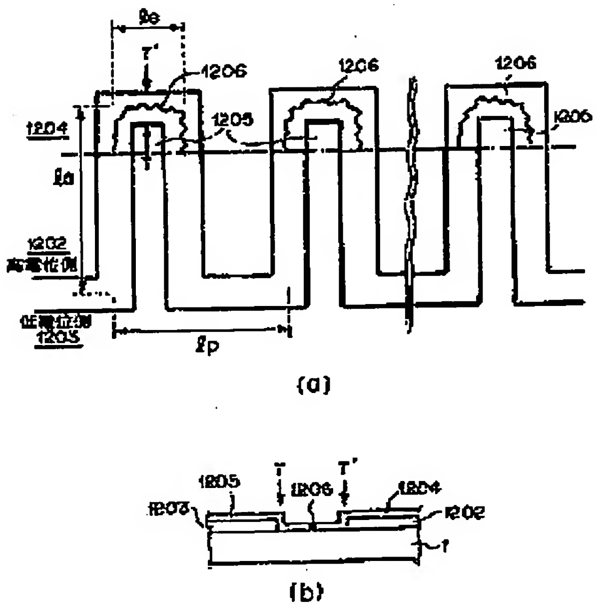
【図20】


TV信号
(無線伝送系)
TV信号
受信回路
143
TV信号
(有線伝送系)
TV信号
受信回路
142
画像入力装置
(TVカメラ)
画像メモリ
インターフェース
回路
141
画像メモリ
(VTR)
画像入力メモリ
インターフェース
回路
140
画像メモリ
(ビデオディスク)
画像入力メモリ
インターフェース
回路
139
画像メモリ
(静止画ディスク)
画像入力メモリ
インターフェース
回路
138
コンピュータ
ネットワーク
プリンタ
入出力インター
フェース回路
135
画像生成回路
137
CPU
136
入力部
(キーボード、
マウス、など)
144
ディスプレイパネル
コントローラ
132
134
デコーダ
画像
メモリ
133
マルチ
プレクサ
131
駆動回路
130
ディスプレイ
パネル

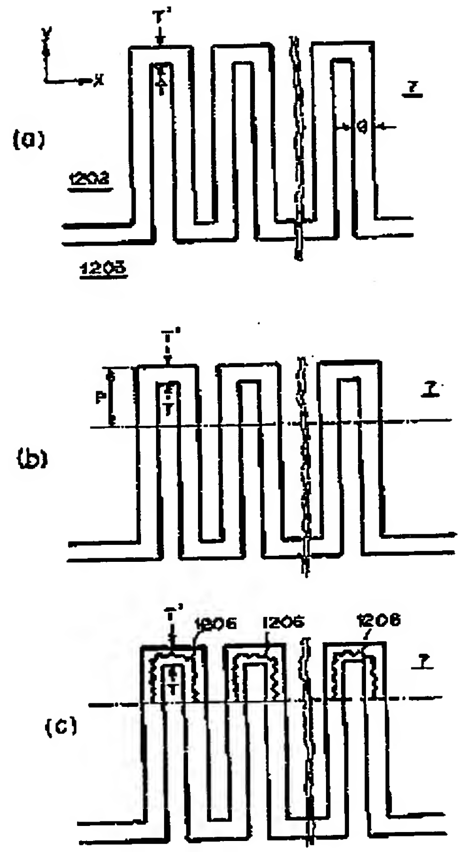
【図26】


16
12

【図21】



【図22】



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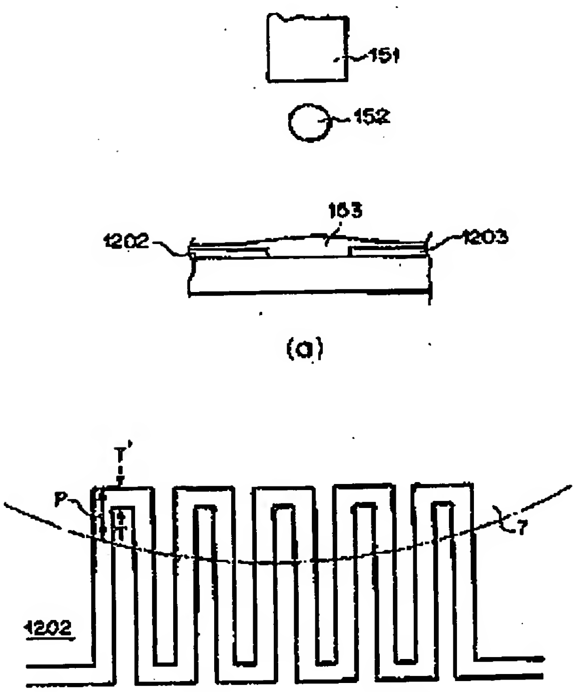
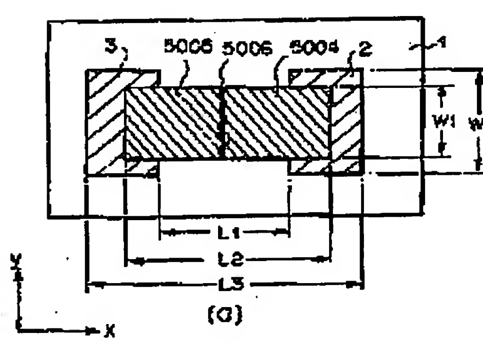
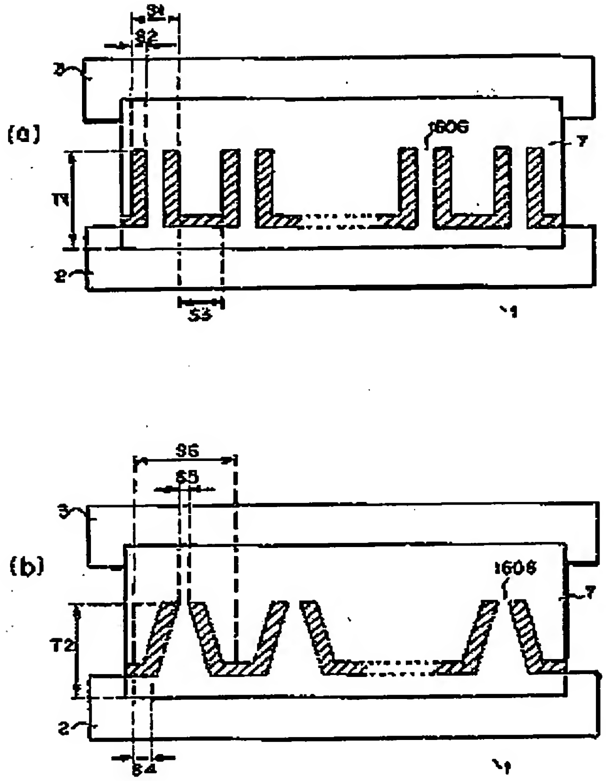


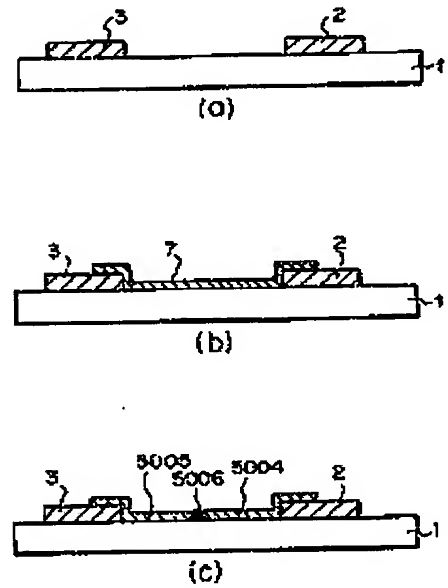
【図25】



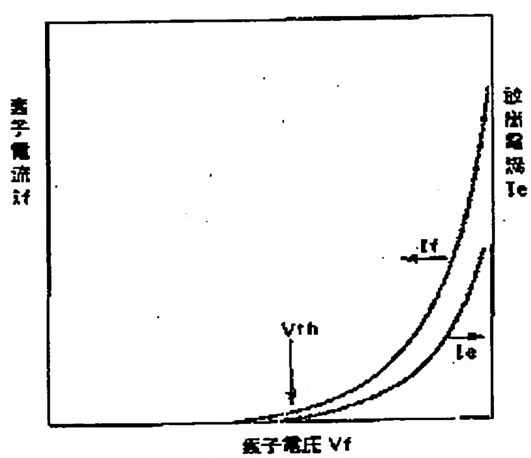
【図24】


(a)
(b)
T1
T2
S1
S2
S3
S4
S5
S6
1606

【図27】


(a)
(b)
(c)
5005
5006
5004

【図28】


Vth
If
Ie
素子電圧 Vf

* NOTICES *

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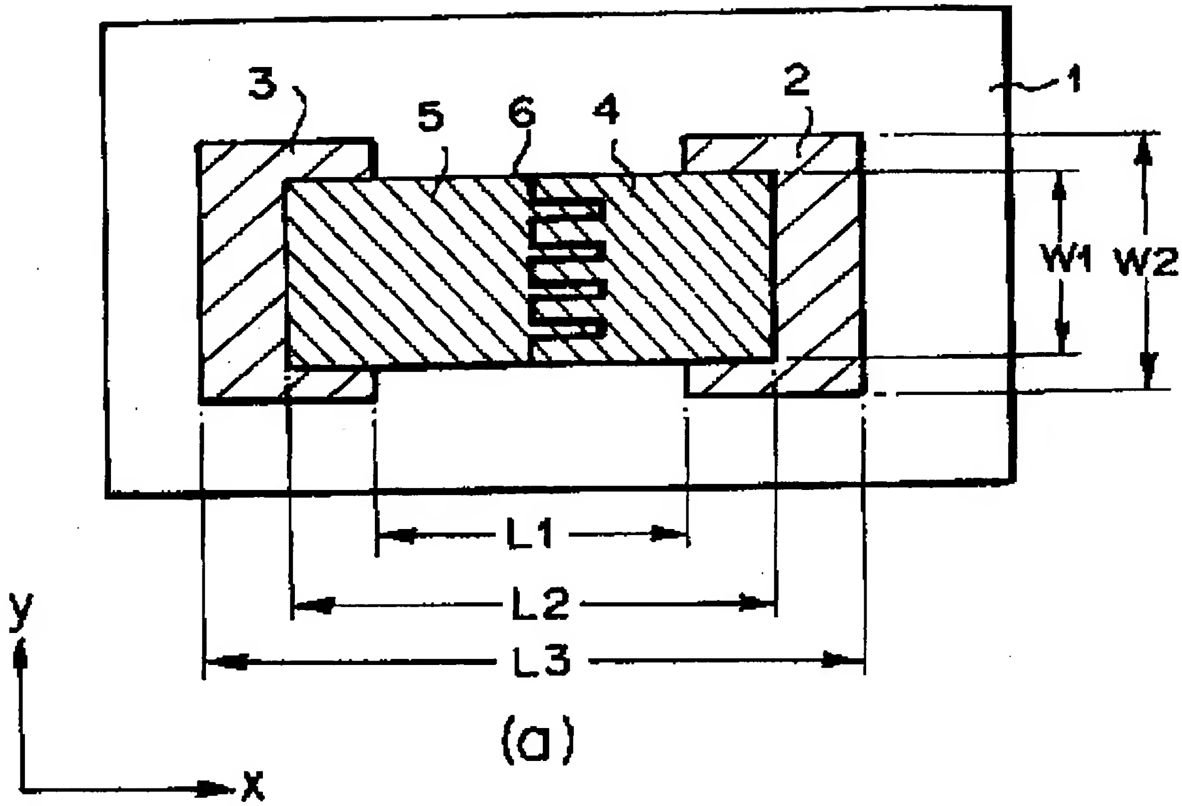
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

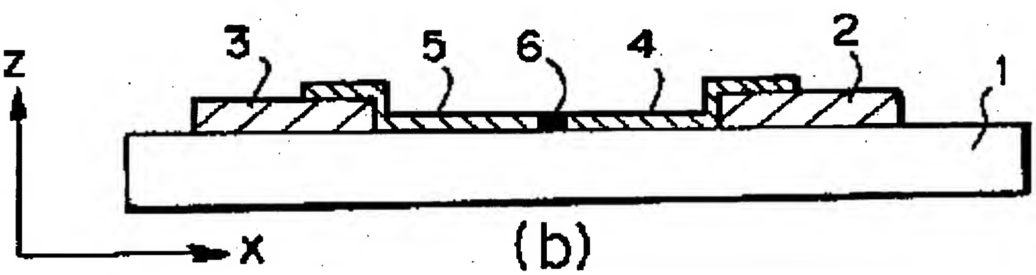
[Claim(s)]
[Claim 1] In the electron emission equipment constituted with the electrode for pulling up the electron emission component which has the conductive thin film which contains the electron emission section in the part, and an electron The part from which one long and slender field insulated electrically is formed in this conductive thin film, and this insulating region was on the high potential side to the convex so that this conductive thin film might be divided into a high potential and low voltage side, the outline which changes from the part which became a convex to a low voltage side -- the electron emission equipment characterized by the continuous linear electron emission section existing in a part of part [at least] which had a periodic configuration and was on the high potential side to the convex in one period of an insulating region.
[Claim 2] Electron emission equipment according to claim 1 characterized by having the deposit which changes from carbon and/or a carbon compound to the above-mentioned electron emission section and its near.
[Claim 3] Electron emission equipment according to claim 1 or 2 with which meandering distance la of the part which was on the die-length [of the electron emission section] le and period lp of this insulating region, and high potential side of this insulating region to the convex, and the part which was on the low voltage side to the convex is characterized by being in the range of a degree type, respectively. [which are contained in 1 period of the above-mentioned insulating region]
5 micrometer<lp <80-micrometer1 micrometer<le -- < -- 40micrometer1 micrometer<la <100micrometer -- [Claim 4] Each part by the side of the above-mentioned quantity potential into which the above-mentioned electron emission component has the component electrode of the pair which counters further, and this conductive thin film was divided, and low voltage The part from which the field which was electrically connected to the each side of the above-mentioned component electrode, and was inserted into this component electrode was on the high potential side to the convex, Electron emission equipment according to claim 1 to 3 characterized by existing in the part from which it has the periodic configuration which changes from the part which became a convex to a low voltage side, and the above-mentioned conductive thin film was mainly on the high potential side to the convex among the fields inserted into the above-mentioned component electrode.
[Claim 5] Electron emission equipment according to claim 1 to 4 with which the above-mentioned electron emission component is characterized by being a surface conduction mold electron emission component.
[Claim 6] In the electron emission equipment constituted with the electrode for pulling up the electron emission component which has the conductive thin film which contains the electron emission section in the part, and an electron The part from which one long and slender field insulated electrically is formed in this conductive thin film, and this insulating region was on the high potential side to the convex so that this conductive thin film might be divided into a high potential and low voltage side, It has a periodic configuration. the outline which changes from the part which became a convex to a low voltage side -- The part which was on the die-length [of a part] le and period lp of this insulating region, and high potential side of this insulating region to the convex, [which were on the high potential side which the continuous linear electron emission section is formed in the insulating region, and is contained in 1 period of this insulating region to the convex] Electron emission equipment characterized by the meandering distance la of the part which was on the low voltage side to the convex and a raising electrode and the potential difference Va between low voltage side conductivity film, and the distance H of a raising electrode and the above-mentioned electron emission component being in the range of a degree type, respectively.
5 micrometer<lp <80micrometer1 micrometer<le <20micrometer5 micrometer<la <100micromVa/H<0.5x106 [V/m]
[Claim 7] Electron emission equipment according to claim 6 characterized by having carbon and/or a carbon compound in the above-mentioned electron emission section and its near.

[Claim 8] Electron emission equipment according to claim 6 or 7 with which the above-mentioned electron emission component is characterized by being a surface conduction mold electron emission component.
[Claim 9] Electron emission equipment characterized by the electron source by which two or more arrangement of one which constitutes electron emission equipment according to claim 1 to 8 of the electron emission components was carried out on the base, and being constituted with the electrode for pulling up an electron.
[Claim 10] Electron emission equipment according to claim 9 with which wiring electrically connected to the electron emission component is characterized by being formed in the shape of a matrix in the above-mentioned electron source.
[Claim 11] Electron emission equipment according to claim 9 with which wiring electrically connected to the electron emission component is characterized by being formed in the shape of a ladder in the above-mentioned electron source.
[Claim 12] Image formation equipment characterized by having the configuration of electron emission equipment according to claim 9 to 11, and having the function of an image formation member in which the above-mentioned electronic raising electrode emits light, and forms an image by the exposure of the electron ray emitted from the above-mentioned electron source.
[Claim 13] The manufacture approach of the electron emission equipment characterized by forming the electron emission section by being the manufacture approach of electron emission equipment according to claim 1, forming parts other than the inner electron emission section of the above-mentioned insulating region by removing some conductive thin films for the above-mentioned conductive thin film with the ultra-fine processing technology of either a focused ion beam method, a laser process or the photolithography method, impressing an electrical potential difference subsequently to this conductive thin film, and passing a current.

[Translation done.]



(a)



(b)

NOTICES *

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**** shows the word which can not be translated.
In the drawings, any words are not translated.

ETAILED DESCRIPTION

)etailed Description of the Invention]

001]
'ield of the Invention] This invention is concerned with image formation equipments, such as a display which are an ectron source and its application, and relates to image formation equipments, such as a display which are the electron nission equipment which used the surface conduction mold electron emission component of a new configuration, and especially, an electron source, and its application.

002]
)escription of the Prior Art] As a description, the electron emission equipment using a surface conduction mold ectron emission component has simple structure, and is easy to manufacture, and since it can drive by the driver ›ltage of several 10 [V] extent from a number [v], development research has been made by these people as a onotonous mold display recently.

003] The configuration and the manufacture approach of electron emission equipment of having used a surface ›nduction mold electron emission component and this are explained by JP,7-235255,A etc. in full detail. Below, it :plains briefly.

'004] Drawing 25 is the schematic diagram of the conventional surface conduction mold electron emission ›mponent. It is what (a) regarded the component as from right above, and (b) sees from width. 1 is a substrate, and 2 a component positive electrode, and 3 is a component cathode and is connected with the non-illustrated power ›urce. 5004 and 5005 are conductive thin films, and 5004 is electrically connected with the component cathode 3 for e component positive electrodes 2 and 5005. The thickness of electrodes 2 and 3 is an about several micrometers ing from several 10nm. On the other hand, the thickness of the conductive thin films 5004 and 5005 is the thing of 1 .m] to several 10 [nm] extent. 5006 is a crack and makes the conductive thin films 5004 and 5005 discontinuity ostly electrically. Although the description of a crack is described in a production process, after a component is ›rmed, the electron is carrying out dispersion injection from near the point of the component anode plate of a crack)06.

ı005] Next, the electron emission equipment which used the surface conduction mold electron emission component is :plained along with drawing 26 .

ı006] Drawing 26 is the outline block diagram of the electron emission equipment which used the surface conduction .old electron emission component which has the configuration shown by drawing 25 .

ı007] A high voltage power supply for a raising electrode for an ammeter for a power source for 10 to impress the ›mponent electrical potential difference Vf to a component and 11 to measure the component electrode 2 and the ›mponent current If which flows between three, and 12 to catch the attainment current Ie emitted from the electron nission section of a component, and 13 to impress an electrical potential difference Va to the raising electrode 12, and 4 are the ammeters for measuring the current Ie which was emitted from the surface conduction mold electron nission component, and reached the raising electrode. Furthermore, if needed, mesh-like an electrode or a fluorescent :reen pulls up, and it is attached in the electrode 12 so that distribution of an electronic attainment location can be ıeasured. In making an electron emit, the power source 10 connected with the component electrodes 2 and 3, it pulled ɔ with this electron emission component, and the power source 13 has connected with an electrode 12. Furthermore, ı case the component currents If and Ie are measured, as shown in drawing, ammeters 11 and 14 have connected, :spectively.

)008] Into the vacuum housing 16, the surface conduction mold electron emission component and the raising electrode :e installed, as shown in drawing, and each electrical potential difference etc. can be controlled now from the outside f a vacuum housing. In addition, the exhaust air pump 15 serves as further the usual high vacuum exhaust air system

/hich consists of a turbine pump and a rotary pump from the ultra-high-vacuum exhaust air system which consists of n ion pump. Moreover, the vacuum housing 16 whole and an electron emission component substrate can be heated at a on-illustrated heater.
0009] The component electrical potential difference Vf comes to be adjustable so that 0 to several 10 [V] extent and ne electrical potential difference Va of a raising electrode may become a number [KV] from 0. The distance H of a aising electrode and an electron emission component is the order of number [mm] extent.
0010] Next, drawing 27 describes the example about the manufacture approach of a surface conduction mold electron mission component.
0011] The photoresist pattern (negative) of the component electrodes 2 and 3 is formed on the substrate 1 which ormed the silicon oxide of thickness 0.5 [mum] extent by the spatter on the blue plate glass which carried out [process-.] defecation, and the sequential deposition of Ti of thickness 5 [nm] and the nickel of thickness 100 [nm] is carried out vith a vacuum deposition method. A photoresist pattern is dissolved by the organic solvent, lift off of the nickel/Ti leposition film is carried out, and the component electrodes 2 and 3 are formed (drawing 27 (a)).
0012] [Process-b], then Cr film of thickness 100 [nm] extent are deposited with vacuum deposition, and the onductive thin film 7 which consists of a particle which mainly consists of oxidization palladium is formed by arrying out patterning so that it may have opening corresponding to the configuration of a conductive thin film, and otation spreading and carrying out heating baking processing continuously by the spinner in organic Pd compound ccp4230 Okuno Pharmaceuticals company make) on it with a phot lithography techniques. In addition, the particle ilm described here is film with which two or more particles gathered, and not only the condition that the particle listributed separately but a particle points out mutually contiguity or the film in the condition (the shape of an island is ilso included) of having overlapped, as the fine structure.
0013] The [process-c] Cr film is etched by acid etchant and the pattern of the desired conductive thin film 7 is formed y lift off (drawing 27 (b)).
0014] After installing a component in [process-d], next the electron emission equipment of drawing 26 , exhausting vith a vacuum pump and reaching the degree of vacuum of 2.7x10-3Pa (2x10-5Torr) extent, according to the power ource 10 for impressing the component electrical potential difference Vf to a component, an electrical potential lifference is impressed between the component electrode 2 and 3, respectively, and energization processing called oaming is performed. This carries out energization processing, carrying out and carrying out rising voltage of the lectrical potential difference to the shape of a pulse according to a power source 10. The conductive thin film 7 breaks, leforms or deteriorates locally by this energization processing, and the crack section 5006 is formed (drawing 27 (c)). Moreover, to coincidence, during foaming processing, the conductive thin film 7 inserts a resistance measurement pulse etween energization pulses, and measures resistance on the electrical potential difference of extent which does not lestroy and deform locally, for example, the electrical potential difference of 0.1 [V] extent. By that measurement, ermination of foaming processing is considered as the time of resistance of the conductive thin film 7 becoming more han abbreviation 1M ohm, and ends impression of the electrical potential difference to a component at this time.
0015] It is desirable to perform processing called an activation process to the component which finished [process-e] oaming. An activation process is a process from which the component current If and the attainment current Ie change vith these processes remarkably. An activation process can be performed by repeating impression of a pulse like nergization foaming under the ambient atmosphere containing the gas of an organic substance. When the inside of a acuum housing is exhausted using an oil diffusion pump, a rotary pump, etc., it can form using the organic gas which emains in an ambient atmosphere, and also this ambient atmosphere is acquired by introducing the gas of an organic substance suitable in the vacuum once exhausted fully with the ion pump etc. Since it changes with the gestalt of the above-mentioned application, the configuration of a vacuum housing, classes of organic substance, etc., the gas ressure of the desirable organic substance at this time is suitably set up according to a case. As a suitable organic substance, an alkane, an alkene, and the aliphatic hydrocarbon of an alkyne Organic acids, such as aromatic ydrocarbon, alcohols, aldehydes, ketones, amines, a phenol, carvone, and a sulfonic acid, can be mentioned. Specifically The saturated hydrocarbon expressed with Cn H2n+2, such as methane, ethane, and a propane, The insaturated hydrocarbon expressed with empirical formulas, such as Cn H2n, such as ethylene and a propylene, Such mixture, such as benzene, toluene, a methanol, ethanol, formaldehyde, an acetaldehyde, an acetone, a methyl ethyl etone, monomethylamine, ethylamine, a phenol, formic acid, an acetic acid, and a propionic acid, can be used. Carbon or a carbon compound accumulates on a component, and the component current If and the attainment current Ie come to change with these processings from the organic substance which exists in an ambient atmosphere remarkably. The termination judging of an activation process is performed suitably, measuring the component current If and the attainment current Ie. In addition, pulse width, pulse separation, a pulse height value, etc. are set up suitably. Carbon

d a carbon compound are graphite (the so-called HOPG, and PG and GC are included.). Here, crystal grain is nfused and, as for a crystal structure of graphite with nearly perfect HOPG, and PG, the crystal structure is confused ittle with 20 [nm] extent. It is amorphous carbon (the mixture of the microcrystal of graphite is pointed out norphous carbon and amorphous carbon, and the first half), and as for the thickness, considering as the range below [nm] is desirable, and considering as the range below 30 [nm] is more desirable. The effective width of face of a ıck becomes narrow by deposition of this carbon compound, and an electron will carry out dispersion emission from anode plate tip. Moreover, if the location which an electron emits in the component obtained by doing in this way is ualized in the crack direction by the measure of 0[nm] -100[nm], being distributed over continuation in accordance th a crack is known. That is, if it sees in the resolution of 10[nm] -100[nm], the electron emission point exists in ntinuation and homogeneity mostly.

)16] As for the electron emission component pass such a process, it is desirable to perform a stabilization process. is process is a process which exhausts the organic substance in a vacuum housing. As for the vacuum pump 15 ich exhausts a vacuum housing 16, it is desirable to use what does not use oil so that the oil generated from uipment may not affect the property of a component. Specifically, evacuation equipments, such as a sorption pump d an ion pump, can be mentioned. When the organic gas originating in the oil component generated at the process of id activation after this, using an oil diffusion pump and a rotary pump as an exhauster is used, it is necessary to stop partial pressure of this component low as much as possible. the partial pressure on which above-mentioned carbon d an above-mentioned carbon compound do not almost newly deposit the partial pressure of the organic component a vacuum housing -- it is -- below 1.3x10-6Pa (1x10-8 [Torr]) -- desirable -- further -- below 1.3x10-8Pa (1x10-10 orr]) especially is desirable. When exhausting the inside of a vacuum housing furthermore, it is desirable to make sy to heat the whole vacuum housing and to exhaust a vacuum housing wall and the organic substance molecule ich stuck to the electron emission component. Although it is desirable to be 150 degrees or more preferably and to rry out long duration processing as much as possible 250 degrees from Centigrade 80 as for the heating conditions at is time, they are not restricted to especially this condition and the conditions suitably chosen according to terms and nditions, such as magnitude of a vacuum housing and a configuration of a configuration and an electron emission mponent, perform them. The pressure in a vacuum housing needs to make it low as much as possible, below its 3x10-5Pa (1x10-7 [Torr]) is desirable, and below its 1.3x10-6Pa (1x10-8 [Torr]) especially is desirable to a pan. lthough it is desirable to maintain the ambient atmosphere at the time of the above-mentioned stabilizing treatment mination as for the ambient atmosphere at the time of a drive after performing a stabilization process, if it does not strict to this and the organic substance is removed enough, even if some degree of vacuum itself falls, it can maintain sufficiently stable property. H2 O which could control deposition of new carbon or a carbon compound, and stuck to e vacuum housing, the substrate, etc. by adopting such a vacuum ambient atmosphere, and O2 etc. -- it can remove d the component current If and the attainment current Ie are stabilized as a result.

017] The basic property of this electron emission equipment created by the above component configurations and the anufacture approach is explained using drawing 28 . The typical example of the relation between the attainment ırrent Ie and the component current If which were measured by the electron emission equipment shown in drawing ; , and the component electrical potential difference Vf is shown in drawing 28 . Since the attainment current Ie is markably small compared with the component current If, drawing 28 is shown per arbitration. Any shaft is expressed ith the linear scale.

018] This electron emission equipment has the following three properties to the relation between the attainment ırrent Ie and the component electrical potential difference Vf so that clearly also from drawing 28 . First, in the first ace, if this electron emission equipment impresses the component electrical potential difference more than a certain ectrical potential difference (Vth of drawing 28 called a threshold electrical potential difference), the attainment ırrent Ie will increase rapidly and, on the other hand, the attainment current Ie will hardly be detected below on the reshold electrical potential difference Vth. That is, it is a nonlinear device with the clear threshold electrical potential fference Vth to the attainment current Ie. Since the attainment current Ie is dependent on the component electrical otential difference Vf the second, the attainment current Ie is controllable by the component electrical potential fference Vf. It depends for the amount of attainment charges caught by the raising electrode 12 the third on the time nount which impresses the component electrical potential difference Vf. That is, the amount of charges caught by the ising electrode 12 is controllable by the time amount which impresses the component electrical potential difference f.

019] According to the above-mentioned property, the electron caught with the raising electrode 12 is controlled by e peak value and width of a pulse-like electrical potential difference which are impressed to the component inter-ectrode which counters above a threshold electrical potential difference. On the other hand, a raising electrode is

ırdly reached below on a threshold electrical potential difference. Therefore, if the above-mentioned pulse-like ectrical potential difference is suitably impressed to each component when many electron emission components have ;en arranged, according to an input signal, a surface conduction mold electron emission component will be chosen, ıd the amount of electron emission can be controlled.

'020] By constituting two or more electron emission equipments based on this principle, it becomes possible to form a onotonous mold image display device. The configuration approach is indicated in detail by JP,7-235255,A. If it states iefly, corresponding to the pixel of a monotonous mold image display device, two or more above-mentioned surface ›nduction mold electron emission components will be arranged on the same substrate, and it will arrange so that iring from each component electrode 2 and 3 may be considered as line wiring and train wiring at the shape of so-ılled passive matrix, respectively. Moreover, although a raising electrode uses a common thing, on a raising electrode, fluorescent screen is applied in the location corresponding to each electron emission component, and it forms the xel. Therefore, it becomes possible to make a pixel turn on with the electron which was able to be pulled up with the .ising electrode. In a drive, the component electrical potential difference on which only the component as which the .atrix was chosen exceeds Vth will be built by giving electropositive potential V (Vth>V>Vth/2) alternatively to line iring, and giving electronegative potential-V (Vth>V>Vth/2) alternatively to train wiring. Only the component as hich the matrix was chosen can be driven now with the property of the electron emission equipment which used this .ing and the surface conduction mold electron emission component mentioned above.

)021] Furthermore, the following invention is made by these people besides the electron emission equipment which ;ed the above general surface conduction components. That is, in JP,1-311532,A, JP,1-311533,A, and JP,1-311534,A, ıe S C E component in which a component anode plate and component cathode do not have a symmetrical ›nfiguration is proposed. It aimed at plastic surgery of the attainment configuration in the raising electrode of an ectron beam in JP,1-311532,A, JP,1-311533,A, and JP,1-311534,A. For that reason, by this invention, an electron :oposes this invention, in order to solve a different technical problem from this purpose so that it may state below.

)022]

'roblem(s) to be Solved by the Invention] In the monotonous mold display according to the principle of the electron nission equipment described in the above-mentioned conventional example, it is desirable for the effectiveness eta 'hich is the ratio of the amount Ie of attainment currents of the electron which reaches the raising electrode 12 to the nount If of component currents and (eta=Ie/If) to be large. That is, if eta can be enlarged, since If required to obtain ıme Ie can be made small, the design of wiring to which a component is connected can be made easy, or it is expected ıat degradation of a component can be reduced.

)023] Therefore, the technical problem which is going to solve this invention is to raise the effectiveness of this lectron emission equipment, with the amount of currents in a raising electrode fixed.

)024] In order to state a technical problem to a detail further to this purpose, the device of this electron emission juipment that used the surface conduction mold electron emission component is explained hereafter.

)025] As stated above, by passing through the process called the process called foaming and activation, a crack exists ı the conductive thin film of a surface conduction mold electron emission component, and this crack is formed so that ıe part which connected the conductive thin film with the component anode plate electrically, and the part electrically onnected with the component cathode, respectively may be divided. It turns out [of finite] that the part which has the 'idth of face of nm order among this thin film crack recognizes die-length existence. Furthermore, various verification xperiments and computer simulation show that an electron is mostly emitted to the method of ** from a part for the oint by the side of the high potential thin film section of the crack of this nm order (if it assumes that it is correctly mitted to directions [electron] from the point of the high potential thin film section, it turns out that it is in agreement 'ithout conflict of an experiment and simulation.). Although the high potential thin film section was connected with ıe electric target including the conductive thin film section 5004 and component positive electrode 2 grade which can onsider that it is almost equipotential, they are things here. Similarly, the conductive thin film 5005 and the part ıcluding component cathode 3 grade it can consider that are almost equipotential are called below the low voltage thin ilm section.

)026] Thus, by considering movement of the electron in an electrostatic field shows that behavior of the electron mitted from the tip of a high potential thin film carries out different behavior from the electron emitted from a cathode ide like a field emission mold electron emission component. Movement of the characteristic electron of the electron mission equipment using a surface conduction mold electron emission component is considered below.

)027] Although the crack in an actual surface conduction mold electron emission component moves in a zigzag irection irregularly and it depends for the amplitude on the formation approach of a component etc., there is much 'hat is below one half extent of the width of face between a component positive electrode and a component cathode.

Therefore, although it is necessary to constitute the theory taken into consideration to meandering of a component, since it is easy, the theoretical model corresponding to a component when the amplitude of meandering is small, and it is described previously first here. That is, electrostatic potential distribution when the crack part is a straight line is described (after consideration when the crack moves in a zigzag direction argues about movement of the electron in a straight-line crack etc., it is considered in a detail, and it decides to describe the technical problem in this invention.). (drawing 5 indicates that the sectional view of potential distribution of each order mentions later drawing 5 and here.)
[0028] The crack 30 section is a straight line, and the electrode of a component and the front face of the thin film section are on the z= 0th page, and it compares with the field (it states in detail in 34 of drawing 6 , and the back.) considered now. It supposes that it has spread with a sufficiently large area, and when you may consider that the potential distribution has made it binary completely by the high potential thin film section 31 and low voltage thin film section 32 side, high potential thin film section side 31 and the low voltage thin film section 32 may be approximated in electrostatics noting that it is 2 electrode plate which counters. Furthermore, as compared with the considered field 34, it pulls up with a component, electric-field distribution (Ex0, Ez) of using surface conduction mold electron emission component when sufficiently long electron emission [distance / with an electrode 12 / H] equipment regards a field (x z) as a Gauss-Argand plane, and it is [0029].
[Equation 1]
式（1）

$$E_x + iE_z = \frac{V_f}{2\pi}\frac{-i}{\sqrt{(x-iz)^2-(D/2)^2}} + i\frac{V_a}{H}$$

It is given by carrying out. Here, i=root (-1) and pi are circular constants. The core of a coordinate is made into the center of a crack and D is the width of face of an effectual crack. Vf As ****28 showed, it is an electrical potential difference concerning a component, and is 0 to several 10 [V] extent. Moreover, Va It is an electrical potential difference between a raising electrode and a component, and the distance H of a component and a fluorescent screen is number [mm] order in several 10 [KV] extent from a number [KV]. Therefore, Va/H is about 106. [V/m] to 107 It becomes the order of [V/m].
[0030] Moreover, the effectual width of face D means the width of face as a parameter at the time of fitting [the above-mentioned formula (1)] so that it may be in agreement with electric field actual from the center of a crack in about several 10 times [of the magnitude of a crack] location. In a surface conduction mold electron emission component, this width of face requires that it is about several nm order as it is experientially sudden.
[0031] It is drawing 5 which expressed the potential distribution which integrated with the electric field described by the formula (1) according to the scale. In drawing 5 , (a) is the potential distribution map of [mm] order. (b) is the potential distribution map of [mum] order, and (c) is the potential distribution map of [nm] order (the thing corresponding to 30, 31, 32, 33, a call, and it for the crack and the high potential thin film section which are approximated by the formula (1), the low voltage thin film section, and the raising electrode 12 is described at drawing 5 , respectively.).
[0032] At this time, it is parallel to a crack (y-axis) on the z= 0th page, and the value of x is [0033].
[Equation 2]
式（2）

$$x_S := \frac{D}{2}\sqrt{1+\left(\frac{2V_f H}{V_a D\pi}\right)^2}$$

It turns out that electric field serve as zero on ******. When it considers that potential is the imaginary part of complex fluid potential, the point that the flow field stagnates is equivalent to the point of electric-field zero with the property as a harmonic function of potential. From the analogy of a fluid and an electrostatic field, hereafter, a stagnation line or the cross-section configuration of a field (x z) is caught, and the straight-line-like part where this electric field stagnate is called a stagnation point 35. Distance xs from the core of this stagnation point 35 It is the die length showing the description of this system.
[0034] It is set to xs >>D to the order in this electron emission equipment, and is xs. It is sufficiently good approximation and is [0035].
[Equation 3]

: (3)

$$x_S = \frac{V_f}{\pi}\frac{H}{V_a}$$

is xs to a next door and the effectual width of face D. It turns out that it does not depend. (xs >> number [nm]) . Va In l[KV] Vf =15[V] and H= 5 [mm], it is xs =23.9 [mum] extent.
)036] (3) Approximation of a formula is electric-field distribution [0037]
Equation 4]
: (4)

$$E_x + iE_z = -\frac{V_f}{2\pi}\frac{i}{x - iz} + i\frac{Va}{H}$$

is equivalent to having approximated and this approximation is xs. When the ratio of crack width of face is ufficiently large, in the field besides a semicircle column about several times the radius of the effectual crack width of .ce D, it turns out from crack 30 center that it is good approximation. (4) It is the so-called rotation electric field which .e 1st term of the right-hand side of a formula expresses. On the other hand, when the electric field which the 2nd term xpresses are called vertical electric field, it turns out that the characteristic electric field of the electron emission juipment which used the surface conduction mold electron emission component can be approximated by the sum of otation electric field and vertical electric field.
)038] It is obtained by integrating with (4) and the potential distribution equivalent to a formula (4) is [0039].
Equation 5]
: (5)

$$V(x + iz) = Im\left(\frac{Vf}{2\pi}\log\left(\frac{x + iz}{x - iz}\right) + i\frac{Va}{H}z\right)$$

becomes. Here, Im expresses imaginary part.
)040] When the electric field given by the formula (1) are analyzed, it turns out that the field where electric field have ie vector component of z-axis positive sense in the high potential thin film section 31 side exists. The configuration of ie field makes a medial axis the center of crack 30 center and a stagnation point 35, and is xs about a radius. It turns ut mostly that it is formed in the shape of [with which the interior which is made into one half, and which is obtained y the parallel displacement of the direction of the y-axis in a semicircle was got blocked] a semicircle column. In this eld, since an electron receives the downward force, this is called the negative inclination field 36 below. The slash nowed the field corresponding to drawing 5 R> 5 (b). When approximation of a formula (4) is realized, on zx-flat urface of this negative inclination field 36, it becomes a perfect semicircle and the field surrounded in a x axis.
)041] Even if an electron is emitted by a certain effectiveness from the point of the high potential thin film part 31 of a iin film as mentioned above, in the negative inclination field 36, it turns out that an electron falls in response to the ownward (drawing z-axis negative direction) force. Furthermore, from various analyses, the electron fell on high otential thin film section 31 front face, the part was absorbed in the high potential thin film 31, it flowed as a omponent current, and it has turned out that parts are again scattered about into a vacuum. Such, after an electron is mitted by the point of the high potential thin film part 31 of a thin film, it repeats fall dispersion, reaches the injury aising electrode 33 having escaped from the negative inclination field, and serves as an attainment current.
)042] Therefore, when long as compared with xs, as x lay length of the high potential thin film section 31 and the low oltage thin film section 32 approximated above, you may consider that the thin film section is the electrode plate /hich counters, and the scale of meandering of a crack is xs. By comparing, as long as it is very small, you may regard : as a straight-line crack.
)043] That is, it is above semantics to deal with the surface conduction mold electron emission component described reviously when a crack can regard it as a straight line. Moreover, above-mentioned "considered field" turns into a field f the prism with which the location of the electronic direction of z cut from the component front face, and was xtended in the direction of y which has the about 2 to 10-time magnitude of a stagnation point in one about about ten .mes [several to] the height of xs of this, and the x directions like 34 of drawing 6 . That is, 1 crack section is xs. It ompares, when the meandering is small, it can consider that it is linear, and the irregularity of the electrode of two omponents and the front face of the thin film section is xs. Compare and it compares with the field flat [remarkably] nd surrounded with 3 this prism. The high potential thin film section and the low voltage thin film section have spread

th a sufficiently large area, and it is 4 H>>xs. When the situation to say is realized, a system may also consider ldenly the electric-field distribution described by the formula (1) or the formula (4). It turns out that the electron iission equipment using a general surface conduction mold electron emission component satisfies the above- :ntioned requirements mostly.
)44] If the field surrounded with this prism is exceeded, an electron will perform movement it can be mostly nsidered that is **** movement by the parallel electric field which pulled up with the component and were shown in ı of drawing 5 between electrodes 33.
)45] Electric-field distribution which is approximated by such a formula (1) or a formula (4) differs in the property narkably with what is formed on the substrate as the electrode corresponding to the equipotential sections 31 and 32 th same prehension electrode which is equivalent to the raising electrode 33. Moreover, when the electrical-potential- :ference value concerning a component is large (for example, when it is Vf =200[V]), by Va =1[KV] and H= 5 [mm], ɔecomes xs =300 [mum] extent, and in order to form a component which is described by the above-mentioned (1) rmula or the formula (4), it is necessary to consider the component of [mm] order. Therefore, when the electrical- ·tential-difference value which a component requires is large and the magnitude of a component is below bmillimeter meter, having different electric-field distribution from characteristic electric-field distribution of an ove-mentioned surface conduction mold electron emission component can guess easily.
046] As mentioned above, since the description of an electrostatic system was described mostly next, it describes that ɘ electrostatic structure of this system is involved in electronic movement.
047] From the law of conservation of energy, the energy of the electron emitted to the component exterior (inside of vacuum) is given by (eVf-Wf). It is Wf, using e as electronic charge here. It considers as the average work relation of gh potential thin film section 31 front face. Vf Since it is several 10 [V] from the number of ** [V] and general work lation is before and after 5 [eV], an electron has the energy of dozens [V] from a number [V]. Although it is known at the electron which has the energy of dozens [eV] extent from a number [eV] has a different property from the ectron of high energy, the property is not known in detail. If elastic scattering starts on high potential thin film section ı front face and the rate of the whole elastic-scattering component is set to beta from many considerations, it turns out at this is about 0.1 or more and or less 0.5 extent. Moreover, since it is quantum theory wave-motion-behavior for ıergy being low, it turns out that there are components scattered on the directions for the unevenness on the front face : a thin film etc. Therefore, classically, the rate scattered about in a certain direction is interpreted as being given :obable.
ı048] For such a dispersion device, it is understood that electronic movement is what should be treated statistically. [oreover, since the value of beta is one or less, it turns out that it decreases by the exponentiation whenever the ectron in a vacuum repeats dispersion.
)049] In case it considers as effectiveness (eta=Ie /If) with the amount (Ie) of currents of the attainment electron to the ıising electrode 33 for a component current (If), such multiple scattering is considered [tending to reduce ffectiveness and]. Therefore, it is necessary to decrease the count of the fall to high potential thin film section 31 front ıce of this electron as a means which raises effectiveness.
)050] As mentioned above, the surface conduction mold electron emission component with the linear crack 30 surely ad the negative inclination field 36 by the shape of a hemicycle mostly, and this negative inclination field 36 has ɔntributed it to the fall to high potential thin film section 31 electronic front face. Therefore, it becomes the most nportant technical problem to control this negative inclination field.
)051] However, it is unknown in the explanation so far as compared with what this negative inclination field 36 is ıade small how much. Next, the characteristic length of this system determined from electronic energy is described. 'his is die length determined from electronic movement.
)052] With the inside of a negative inclination field, and about 30 crack, as 1st about, since it regarded as rotation lectric field, in the formula (4), movement of the electron about the rotation electric field of Va =0 was analyzed. onsequently, the point on the high potential thin film section 31 (x0, 0, 0) -- it is -- etc. -- from simulation, that with vhich the direction of y of distribution of a point of fall integrated the high potential thin film section 31 of the electron njected to the direction was mostly expressed with the following function form, and ******** understood it.
0053]
Equation 6]

ξ(6)

$$f(x)dx = \begin{cases} Ng_0(x)dx & \text{for } D/2 \le x < x_0 \\ \frac{N}{x}dx & \text{for } x_0 \le x \le Cx_0 \\ 0 & \text{for } Cx_0 < x \end{cases}$$

I is a normalization constant and is g0. It is a forward increasing function. C is [0054] here.
Equation 7]
ξ(7)

$$C = \exp\left(-5.6\left(\frac{eV_f}{W_f + eV_f}\right)^2 + 27.3\left(\frac{eV_f}{W_f + eV_f}\right) - 12.2\right)$$

t is the scale-factor parameter which are described by carrying out. That the electronic orbit is determined only for the cale factor of a shot position means that die length characteristic of this system does not exist in the case of Va =0. Moreover, the maximum attainment location is also determined by the multiple of a shot position from the crack center ection. Therefore, the electron injected or scattered about is the location x0 injected mostly. It receives and is naximum [0055].
Equation 8]
ξ(8)

$$Cx_0$$

You may think that it soars to the height (the direction [of z] forward) of ** order. Vf When =14[V] Wf =5.0[eV], it is C= 130, and when x0 =5[nm], it is Cx 0 = 650 [nm] extent.
0056] Thus, since the die length determined from electronic movement was found, it became clear as compared with what the size should be determined for the negative inclination field 36. That is, it is desired by making Cx0 into the unit of die length for the magnitude of the negative inclination field 36 not to be so large.
0057] Next, the effectiveness of meandering of a crack is considered. If the simplified electric field (1) are further approximated from the above-mentioned consideration, it can deform like a formula (4). In order that an electron may pass through the stochastic process of dispersion, moreover, the set of an electronic orbit Having distribution of the almost same concentration as what is obtained on a formula (1), and the thing obtained in the electric field of a formula 4) is shown by count (for example, in a formula (6), although the effectiveness by the existence of the effectual crack) etc. was calculated). Crack width of face is xs enough. If small, it turns out that there is no effect with the existence of D deep to an electron orbit. In the case of this usual electron emission equipment, this requirement is satisfied. . Therefore, you may understand that the electric field of a formula with the effectual sufficiently narrow crack width of face D (D= 0) (4) are the characteristic electric field of the electron emission equipment using a surface conduction electron emission component. Therefore, it is important to consider the electric field in which the effectual crack width of face D pulls up with the sufficiently narrow high potential thin film section (D= 0) 31 and the component section of the low voltage thin film section 32, and is formed with an electrode 33.
0058] Moreover, it is xs also when a crack moves in a zigzag direction. You may approximate that it is the linear combination (superposition) of the electric field which pull up with max, may consider that the ratio (xs/H) of the distance between an electrode 33 and a component is sufficiently small (H>>xs), and pull up with the electric field and the component which the component section of the high potential thin film section 31 without effectual crack width of face and the low voltage thin film section 32 builds, and an electrode 33 makes.
0059] Therefore, though, as for the essential part of the electric field of the winding crack, the width of face of an actual crack has the width of face of finite, it is expected that it is electric-field distribution of the component (D= 0) section of the sufficiently narrow limit of effectual crack width of face.
0060] Count shows meanderingly that the potential distribution which exists on a two-dimensional flat surface and which the component section with the sufficiently narrow crack (D= 0) of crack width of face builds is proportional to the solid angle the high potential thin film section 31 will be wished if potential of the low voltage thin film section 32 is made into zero according to the description of the Green function on half space. Therefore, when the solid angle which desires the high potential thin film section 31 is set to omegalambda (x y, z) to a certain point on the half space which sets the configuration of the high potential thin film section 31 with a configuration to lambda, and is set to z> 0 (x y, z), the potential in the point is [0061].
Equation 9]

式（9）

$$V(x,y,z)=\frac{V_f}{2\pi}\Omega_\Lambda(x,y,z)+\frac{V_a}{H}z$$

It becomes (at the time of Va =0, as shown in drawing 7 , the potential which an electron senses is a solid angle which desires a high potential thin film.). What carried out direction differential of this serves as electric field. For a formula (9), even if the width of face of a crack is limited, the effectual crack width of face D is xs. Above-mentioned consideration shows comparing and being realized in approximation good when sufficiently small.
[0062] Supposing it takes a crack to the y-axis made into = (x y, z) (0y, 0) of xy-flat surface of z= 0, it can check easily that a formula (9) returns to a formula (5).
[0063] From the position of making a negative inclination field small, the relation between (9) types and a negative inclination field is considered below. It can be understood that a negative inclination field is a dominant field of the rotation electric field which an electron emission component builds. That is, it means that the vertical electric field which pull up with the component of the direction of z of the electric field which rotation electric field build exactly, and an electrode 33 builds on the boundary line of a negative inclination field balance, and is that rotation electric field become dominant in the interior further. Moreover, it is Vf if potential of the low voltage thin film section 32 is made into zero. The equipotential line (field) of a value begins from a stagnation point (line), and becomes parallel to xy-flat surface in the sufficiently large place of low voltage thin film section 32 direction. This Vf When the inside (side including a crack) of the equipotential line (field) is called a component potential field, it turns out easily that the negative inclination field is confined in a component potential field. As for this property, a crack does not come together for whether being a straight line.
[0064] Therefore, it is possible by making this component potential field small to make a negative inclination field small. The case of the constituted potential of being characteristic was actually illustrated to drawing 8 .(a) and (c) look at the model of a component from a top, and 31 and 32 are corresponding high potential thin film sections and low voltage thin film sections. Potential distribution of the dotted-line section cross section of a crack where (c) moved [the potential distribution corresponding to the straight-line crack of (a)] in a zigzag direction in (b) is shown in (d). It turns out that the negative inclination field 40 enclosed with a line is small.
[0065] Then, from a formula (9), in order to make a component potential field small, it comes to a conclusion that what is necessary is just to enlarge area of the high potential thin film section 31 which the electron faces to an electronic orbit, and it is done. However, in the conventional surface conduction mold electron emission component, since meandering of a crack was not controlled and control of the electron emission section was not made, this thought was not harnessed.
[0066] This thing is explained in more detail. the crack of drawing 9 (a) which modeled the crack in the conventional surface conduction mold electron emission component since it was easy -- a part -- I will consider the case where it has stood in a line periodically in the linear configuration. The vertical amplitude is 10 [mum] mostly and periods of this are 20 [mum] extent. The rate which the electron emitted at the anode plate tip in this case pulls up, and reaches an electrode is calculated by computer simulation. An axis of abscissa expresses a location and an axis of ordinate is effectiveness. Moreover, the straight line drawn on an axis of abscissa and parallel is as a result of [in a straight-line crack] count. the upper part of a crack -- Cx0 It sets, and if there is a part where the solid angle which can overlook an anode plate exceeds pi, the part which becomes smaller than pi will be made. Reflecting this fact, as shown in drawing 9 (b), the part to cross and the part which has not been crossed exist the effectiveness in a straight-line crack like a graph in effectiveness. Therefore, the part which an electron emits meets a crack, and if distributed over the whole, an average electronic transport factor will become what seldom changes to a linear thing. Moreover, about the amplitude smaller than meandering of the crack of drawing 9 (a), and a period, the difference from the thing in the case of the straight line of the field of negative inclination becomes small effectually from above-mentioned consideration, and it becomes near according to the negative inclination over a linear crack from the form of the negative inclination field of drawing 9 (a). Therefore, it can guess that the effectiveness of small meandering can be disregarded. By simulation, when a numerical simulation was done, such effectiveness was actually acquired.
[0067] That is, since the part where a negative inclination field becomes large is made to coincidence above at least even if the part which makes a negative inclination field small is formed when the amplitude of meandering is not not much large, with a simple meandering crack, it comes to a conclusion further that it is impossible the whole electronic transport factor and to improve effectiveness.
[0068]

leans for Solving the Problem] The technical problem of this invention is raising the effectiveness which is a ratio ith the amount of currents of the electron which controls the electric field which the electron already emitted to the mponent exterior (inside of a vacuum) receives, pulls up a surface conduction mold electron emission component ith the flowing amount of currents, and reaches an electrode. Also ideologically means by which that purpose solves is technical problem unlike control of electric field for this thing to take out an electron out of the matter therefore ill completely differ, and effectiveness will also completely differ.
069] There is a negative inclination area size as one of the factors which govern effectiveness as mentioned above, ıd it was shown that the magnitude is dependent on a configuration. In this invention, the above-mentioned technical oblem is solved by control of the configuration of the crack by control of this negative inclination field, and control the location of the electron emission section.
070] That is, in a part for the heights of the part which was on the high potential thin film section side of a crack to e convex, since the negative inclination field is small, distribution of an electron emission part will be controlled so at an electron may emit only the part.
071] Although stated in detail below, by making an electron emit alternatively only from the large part of an ectronic transport factor, all average electronic transport factors can be improved and effectiveness will become markably large.
072] Then, if it carries out what, it will be this invention which gave and constituted the design manual of whether to e able to enlarge effectiveness. If the part which emits the electron which met the crack by passing through the process f activation in the surface-conduction mold electron-emission component is averaged in the field which met the crack f several 10 [nm] to 100 [nm] at least and it watches by the measure of the die length beyond it, it is known that the qualized distribution of a part which carries out electron emission is almost continuous in accordance with a crack, niform, and continuation. If this surface conduction mold electron emission component and a characteristic property re used, it is possible to design and constitute the electron emission section from above semantics as a segment ontinuously. This invention gave and constituted the design plan which raises effectiveness, without reducing the mount of currents in a raising electrode by using the property in which this surface conduction mold electron emission omponent is remarkable.
0073] Moreover, in order to make a negative inclination field small as mentioned above, some variations can be onsidered in that configuration, but since they are constituted efficiently, in this invention, it limits to the periodic onfiguration (it is easily possible to transpose this periodic configuration to a more general non-period configuration.).

0074] Moreover, although there is a various thing in the configuration stated by this invention etc. and various shape arameters are included, the configuration has fundamentally three parameters, a period lp, the amplitude la, and the lie length (emission division manager) le of the part which an electron emits as a common factor. The role of these hree shape parameters is explained in accordance with the typical configuration of this invention.
0075] The typical example of this invention was illustrated to drawing 10 . In accordance with this example, it lescribes what kind of change effectiveness and the amount Ie of currents in a raising electrode carry out with an ıbove-mentioned parameter. The guide which designs a crack configuration and is controlled is given so that a arameter area which effectiveness actualizes may be determined and a shape parameter may consist of the result in his field. The control crack in alignment with the guide shows that it becomes possible to solve the technical problem of this invention of raising effectiveness, without reducing the amount Ie of currents.
0076] (a) of drawing 10 is the configuration Fig. of the simplest this invention. As shown in drawing, a crack is controlled artificially and it is made the periodic rectangle configuration which consisted of an angle of 90 degrees, and segment. A thick wire 38 is the electron emission section among drawing. He is trying for an electron to emit in 38 oarts of a crack from the tip of the high potential thin film section in alignment with a crack. Other crack parts are lesigned so that an electron may not emit by a certain approach. The die length of the segment of the isolated electron emission section is set to le. Moreover, the amplitude at the time of making the direction of y into a standard was set to la as shown in drawing. Moreover, the period of a periodic pattern was set to lp.
0077] First, I will consider le dependency. In addition, the parameter group was fixed, it pulled up with effectiveness eta, and drawing 10 (b) showed the le dependency of the ratio from the thing of the crack of the straight line of the amount Ie of currents in an electrode. As shown in drawing, the more le becomes small, the more it turns out that effectiveness improves. however, with a surface conduction mold electron emission component, since the electron emission point exist continuously if it see in the resolution more than at least 100 [nm] and the burst size of the electron in the tip of the high potential thin film section will decrease to linearity in connection with it if the die length of the electron emission section be reduce, as show in (b) of drawing 10 , the amount Ie of currents have a peak (Ie be

proportional to the product of effectiveness and die length le.).
[0078] Similarly, other parameters were fixed and the (c) Fig. of drawing 10 looked at the dependency of the effectiveness at the time of changing the period lp of a crack configuration. While what (it is the increment in monotone) effectiveness rises is known so that lp becomes large, it turns out that it is completed by the dependency. Moreover, component length W1 If it fixes, since it is equivalent to shortening all the electron emission division managers to increase a period therefore, enlarging lp becomes the factor which makes small the amount Ie of currents in a raising electrode as an actual problem (Ie is proportional to eta mostly and mostly in inverse proportion to lp.): Component length W1 The dependency of Ie at the time of fixing is shown in drawing 10 (c). Therefore, depending on the effectiveness made into the purpose like le, the optimal field exists also in lp.
[0079] Moreover, the amplitude la of a crack and the relation of effectiveness were shown in (d) of drawing 10 R> 0. Since it is not related to the electron emission division manager in the case of the configuration which considers the amplitude now, only by the lp dependency of le letting effectiveness eta pass, it exists, and Ie is proportional to effectiveness eta. Although effectiveness increases in monotone with the increment in la, this is also converged on a certain value. Moreover, in making an actual component, since this la is various, it is necessary to stop at the die length of finite, and it has an optimum value as an actual problem too.
[0080] thus -- although the case of a certain kind of configuration (drawing 10 (a)) was considered -- these results -- a shape parameter -- complicated -- becoming entangled -- potential Va of a raising electrode Electrical potential difference Vf of a component etc. -- the value may be changed a lot However, a qualitative property is as having mentioned above.
[0081] For example, consideration with the same said of a case like drawing 11 is possible.
[0082] Then, as a result of inquiring based on the conditions usually considered, it turned out that it is good to choose the following parameters in this invention.
[0083] 5[mum] <lp<80[mum]
1[mum] <le<40[mum]
1[mum] <la<100[mum]
The desirable characteristic die length la of meandering is the scale xs of a stagnation point. It compares and sets up more greatly than same extent or the same it.
[0084] Moreover, in the conventional meandering, since the amplitude was small, when the electronic increment and the electronic decrement of emission effectiveness from the heights and the crevice by the side of the high potential of meandering canceled and it was not different from linear effectiveness, it had become.
[0085] However, it is not this limitation when the amplitude la is sufficiently long. As shown in drawing 12 , the controlled crack is constituted and it considers making an electron emit throughout this crack. If the emission effectiveness of the electron per unit length is called an effectiveness consistency, distribution of an effectiveness consistency can give a definition along with the stroke of a crack. At this time, if the amplitude la becomes large, the effectiveness consistency (it is equivalent to the 38 sections of drawing 12) in heights will increase nonlinear to la. On the other hand, in a crevice (equivalent to the 39 sections of drawing 12), since an effectiveness consistency is a non-negative function, it turns out that it has a minimum. When la is small, it is the effectiveness of meandering with the conventional surface conduction mold electron emission component that the effectiveness (**) of the integral value, i.e., this system, with which it integrated to the emission section which both could linearize around la=0 and met the crack is not different from a linear thing.
[0086] However, when la is enlarged, the electron emission effectiveness consistency in heights may become large, and it may become larger than the thing at the time of the integral value (total efficiency) covering the whole region being a straight line. This thing is depending greatly to a configuration, and is called for as an integral of a distribution function (it is a certain field, and if that measure is small and the effectiveness consistency of other fields is much [thing / of a straight-line crack] less even if there is a part with a very high effectiveness consistency, a total efficiency will become smaller than the thing of a straight-line crack.). However, it turned out that it becomes possible to enlarge electron emission effectiveness by numerical simulation and experiment to the configuration of extent shown in drawing 11 when it had the continuous electron emission section. The desirable range is as follows as a result of inquiring like ****. In addition, le shows the die length of the part jutted out over the high potential side among insulating regions here.
[0087] 5[mum] <lp<80[mum]
1[mum] <le<20[mum]
5[mum] <la<100[mum]
Therefore, it stands on the above-mentioned design concept, and this invention offers the electron emission equipment

.ng the surface conduction mold electron emission component which has a crack with the controlled following nfigurations, and the controlled electron emission section.
)88] Namely, the 1st operation gestalt of this invention is set to the electron emission equipment constituted with the ;ctrode for pulling up the electron emission component which has the conductive thin film which contains the ;ctron emission section in the part, and an electron. The part which was electrically insulated so that this conductive .n film might be divided into a high potential and low voltage side and from which one long and slender field where dth of face D fills conditions and >>(VfH/VaD) 1 is formed in this conductive thin film, and this insulating region ıs on the high potential side to the convex, the outline which changes from the part which became a convex to a low ltage side -- it is the electron emission component characterized by the continuous linear electron emission section isting in a part of part [at least] which had a periodic configuration and was on the high potential side to the convex one period of an insulating region.
)89] This invention includes that it is characterized by having further the deposit which changes from carbon and/or a rbon compound to the above-mentioned electron emission section and its near.
)090] It is electron emission equipment characterized by this invention having the meandering distance la of the part ıich was on the die-length [of the electron emission section] le and period lp of this insulating region, and high ·tential side of this insulating region to the convex again, and the part which was on the low voltage side to the nvex in the range of a degree type, respectively. [which are contained in 1 period of the above-mentioned insulating gion]
)091] The whole rate of electron emission sets up the 5 micrometer<lp <80micrometer1 micrometer<le ;0micrometer1 micrometer<la <100micrometer book above-mentioned parameter so that a crack may become 1.2 or ɔre times of the effectiveness of a linear electron emission component. Moreover, la is decided according to factors, ch as a pixel pitch.
)092] In addition to the above-mentioned conditions, the above-mentioned electron emission component which has ɜ conductive thin film which contains the electron emission section in the part this invention Furthermore, each part ˈ the side of the above-mentioned quantity potential into which it has the component electrode of the pair which ·unters and this conductive thin film was divided, and low voltage The part from which the field which was ɜctrically connected to the each side of the above-mentioned component electrode, and was inserted into this ımponent electrode was on the high potential side to the convex, It has the periodic configuration which changes from e part which became a convex to a low voltage side, and the electron emission equipment characterized by existing in e part from which the above-mentioned conductive thin film was mainly on the high potential side to the convex nong the fields inserted into the above-mentioned component electrode is included.
)093] This invention includes further that the above-mentioned electron emission component is a surface conduction old electron emission component.
)094] In the electron emission equipment constituted with an electrode for the 2nd operation gestalt of this invention pull up the electron emission component which has the conductive thin film which contains the electron emission ction in the part, and an electron The part from which one long and slender field insulated electrically is formed in is conductive thin film, and this insulating region was on the high potential side to the convex so that this conductive in film might be divided into a high potential and low voltage side, It has a periodic configuration. the outline which ıanges from the part which became a convex to a low voltage side -- The part which was on the die-length [of a part] and period lp of this insulating region, and high potential side of this insulating region to the convex, [which the ɪntinuous linear electron emission section is formed in the insulating region, and were on the ****** quantity ɔtential side to the convex into 1 period of this insulating region] It is electron emission equipment characterized by ılling up with the potential difference Va between the meandering distance la of a part and the raising electrode which ɜcame a convex, and the conductive film by the side of the electric conduction by the side of low voltage, and the .stance H of an electrode and the above-mentioned electron emission component being in a low voltage side in the .nge of a degree type, respectively.
)095] 5 micrometer<lp <80micrometer1 micrometer<le <20micrometer5 micrometer<la <100micromVa/H<0.5x106 //m]
he upper limit of electric-field Va/H is given based on the fact [say / that the electron emission effectiveness of the ırt which became a convex from this to big Va/H at the high potential side does not become large enough].
)096] The above-mentioned electron emission component which has further the conductive thin film which contains ıe electron emission section in the part this invention Furthermore, each part by the side of the above-mentioned uantity potential into which it has the component electrode of the pair which counters and this conductive thin film ·as divided, and low voltage The part from which the field which was electrically connected to the each side of the

ibove-mentioned component electrode, and was inserted into this component electrode was on the high potential side o the convex, It has the periodic configuration which changes from the part which became a convex to a low voltage ide, and the above electron emission equipment characterized by existing so that the above-mentioned conductive thin ilm may be pinched by the above-mentioned component electrode is included.

0097] This invention includes having carbon and/or a carbon compound in the above-mentioned electron emission ection and its near further.

0098] This invention is electron emission equipment with which the above-mentioned electron emission component is urther characterized by being a surface conduction mold electron emission component.

0099] The 3rd operation gestalt of this invention is electron emission equipment constituted with the electrode for oulling up the electron source and electron with which two or more arrangement of one which constitutes above electron emission equipment of the electron emission components was carried out on the base.

0100] This invention includes further that wiring electrically connected to the electron emission component is formed n the shape of a matrix in the above-mentioned electron source.

0101] This invention includes further that wiring electrically connected to the electron emission component is formed n the shape of a ladder in the above-mentioned electron source.

0102] The 4th operation gestalt of this invention is image formation equipment which has the configuration of above electron emission equipment and has the function of an image formation member in which the above-mentioned electronic raising electrode emits light, and forms an image by the exposure of the electron source emitted from the ibove-mentioned electron source.

0103] The 5th operation gestalt of this invention is the manufacture approach of electron emission equipment given in he beginning of this section. For parts other than the inner electron emission section of the above-mentioned insulating egion, the above-mentioned conductive thin film A focused ion beam method, It is the manufacture approach of the electron emission equipment characterized by forming the electron emission section by forming by removing some conductive thin films with the ultra-fine processing technology of either a laser process thru/or the photolithography nethod, impressing an electrical potential difference subsequently to this conductive thin film, and passing a current.

0104]

Embodiment of the Invention]

0105]

Example] Hereafter, based on an example, this invention is explained further.

0106] (Example 1) Although the electron emission component of this example is shown in drawing 1 , it has the same configuration as drawing 25 shown in the conventional example. However, the configuration of the crack 5006 which had not been controlled by the conventional example is controlled by this invention, and is carried out like a crack 6. The manufacture approach of the electron emission component of this example is explained using drawing 3 .

[0107] The laminating of Ti with a thickness of 5nm and the Pt with a thickness of 30nm was carried out to the quartz-glass substrate 1 washed by process-a neutral detergent, pure water, and the organic solvent one by one with the vacuum deposition method. After having exposed, having used the photo mask, having developed it continuously, after having continued, the photoresist (AZ1370; Hoechst A.G. make) and forming a resist layer, and forming the resist pattern of the component electrodes 2 and 3, wet etching of the unnecessary part of the PtTi film was carried out, it was removed, finally the organic solvent removed the resist pattern, and the component electrodes 2 and 3 were formed. [applied and] 20 micrometers and the electrode length W2 set spacing L1 of a component electrode to 300 micrometers (drawing 3 (a)).

[0108] With the process-b vacuum deposition method, opening corresponding to the configuration of a conductive thin film for Cr film (un-illustrating) with a thickness of 50nm was formed by the technique of deposition and the usual photolithography, and it considered as Cr mask.

[0109] It continued, the solution (Okuno Pharmaceuticals; CCP-4230) of organic Pb compound was heated and calcinated at 310 degrees C in spreading and atmospheric air, and the thin film which consists of a particle which uses oxidization palladium (PdO) as a principal component was formed. Then, the conductive thin film 7 which has the pattern of removal and a request by lift off of Cr mask by wet etching was formed. The resistance of a conductive thin film is Rs=4.0x104. They were omega/** (drawing 3 (b)).

[0110] The insulating region of a configuration as shown in drawing 13 (a) was formed by installing the process-c above-mentioned component in focusing ion beam machining equipment (FIB), carrying out sputtering of the part of a request of a conductive thin film by FIB, and removing it. Here, they could be Ie=5micrometer, lp=9micrometer, and la=10micrometer.

[0111] In addition, width of face of an insulating region was set to 40nm in the part (part shown by the thick wire of

drawing 13 (a)) of a convex, and others (part shown with the thin line of drawing 13 (a)) could set it 1 micrometer at the high potential side. This is for making only the part of a convex into the electron emission section at a high potential side.
[0112] The above-mentioned component was installed in the vacuum processor of process-d drawing 2 , and activation was performed to it. Drawing 2 has the same configuration as drawing 26 shown in the conventional example here.
[0113] n-hexane was introduced and the pressure was set to 2.7x10 to 2 Pa, once exhausting vacuum devices 16 to a high vacuum with a vacuum pump 15. The pulse voltage was impressed among the component electrodes 2 and 3, and activation was performed. The used pulse is a square wave pulse and pulse width T1= 500microsec, pulse-separation T2=10msec, and peak value were made to increase gradually from 10V to 18V at the rate of 0.2 V/min.
[0114] Installation of a process-en-hexane was stopped, and it exhausted with the vacuum pump 15, heating the vacuum-devices 16 whole at about 200 degrees C. The pressure declined up to 4.2x10 to 4 Pa 24 hours after. In addition, when the component was observed with the scanning electron microscope, the deposit was observed on the above-mentioned electron emission section and the outskirts of it after process-d. This is considered to be carbon and/or a carbon compound in the light of the knowledge about the conventional surface conduction mold electron emission component.
(Example 1 of a comparison) Process of an example 1 - After performing the same process as a and process-b, the electron emission section was formed by the following energization foaming processings.
[0115] -c processes were installed in the vacuum processor of drawing 2 , and exhaust air and a pressure were decompressed for the interior of a vacuum housing by 2.0x10 - 3 or less Pa with the vacuum pump 15.
[0116] It continued and the pulse voltage was impressed among the component electrodes 2 and 3. Pulse shape is a triangular wave pulse and is set to pulse width T1=1msec and pulse-separation T2=10msec, and the pulse height value was begun from 0.1V, and was made to increase gradually at the rate of 1 V/min. When peak value was set to 5V, since the component current fell quickly, foaming processing was ended.
[0117] Then, process of an example 1 - The same processing as d and process-e was performed.
[0118] About the component of the above-mentioned example 1 and the example 1 of a comparison, the electron emission characteristic was measured with the equipment of drawing 2 . At that time, by the pulse voltage impressed to the component, pulse width T1= 100microsec, pulse-separation T2=10msec, and the square wave pulse of pulse height value 17V, it pulled up with the component and the distance H of an electrode set potential of 4mm and a raising electrode to 1kV. A result is shown in Table 1. In addition, eta shows electron emission effectiveness (Ie/If).
[0119]
[Table 1]
Table [ ] 1 If (mA) Ie (muA) eta (%)
Example 1 1.2 2.9 0.24 Example 1 of a comparison 2.0 2.2 It is a process as well as 0.11 (example 2 of a comparison) example 1. - a and b are performed and the conductive thin film which consists of a PdO particle is formed. It continues and a straight-line-like insulating region is formed with process-c focused ion beam equipment. At this time, a part with a width of face [40nm] of with a die length of 5 micrometers is arranged a part with a width of face of 1 micrometer and by turns. The pitch is 9 micrometers. That is, when the parameter la of the component of an example 1 is set to 0, it hits.
[0120] Like the following, the component was created and the property was measured.
[0121] The result became If=1.1mA, Ie=1.1microA, and eta= 0.10%.
[0122] (Example 2) The configuration of an insulating region is shown in drawing 13 (a), was set to le=5micrometer, lp=9micrometer, and la=5micrometer, and produced others according to the same process as an example 1.
[0123] (Example 3) The configuration of an insulating region is shown in drawing 13 (a), was set to le=5micrometer, lp=9micrometer, and la=2micrometer, and produced others according to the same process as an example 1.
[0124] The electron emission characteristic of the above-mentioned component was measured by the same approach as an example 1. A result is shown in Table 2.
[0125]
[Table 2]
Table [ ] 2 If (mA) Ie (muA) eta (%)
Example 1 1.2 2.9 0.24 Example 2 1.2 2.0 0.17 Example 3 1.1 1.4 The configuration of 0.13 (example 4) insulating region is shown in drawing 13 (a), was set to Ie=10micrometer, lp =24micrometer, and la=5micrometer, and produced others according to the same process as an example 1.
[0126] (Example 5) The configuration of an insulating region is shown in drawing 13 (a), was set to Ie=20micrometer, lp =44micrometer, and la=5micrometer, and produced others according to the same process as an example 1.

0127] As a result of measuring the electron emission characteristic on the same conditions as an example 1 about the ;omponent of examples 4 and 5, it became as it is shown in Table 3.
0128]
Table 3]
Table [ ] 3 If (mA) Ie (muA) eta (%)
Example 4 1.2 1.8 0.15 Example 5 1.2 1.6 The configuration of 0.13 (example 6) insulating region is shown in drawing 13 (a), was set to Ie=2micrometer, lp=7micrometer, and la=20micrometer, and produced others according to the same process as an example 1.
0129] (Example 3 of a comparison) The same thing as an example was created except having been referred to as p=4micrometer among the parameters of an example 6.
0130] (Example 7) This example was also produced according to the same process as an example 1. However, it considered as the configuration as showed the processing configuration in process-c to drawing 13 (b). In addition, width of face of an insulating region was set to 40nm in the part (part shown by the thick wire of drawing 13 (b)) of a convex, and others (part shown with the thin line of drawing 13 (b)) could set it 1 micrometer at the high potential side. This is for making only the part of a convex into the electron emission section at a high potential side.
0131] (Example 8) The configuration of an insulating region should be shown in drawing 13 (c). The making process presupposed that it is the same as that of an example 6.
0132] (Example 9) The configuration of an insulating region should be shown in drawing 13 (d). The making process presupposed that it is the same as that of an example 6.
[0133] The electron emission characteristic of the above-mentioned component was measured. The peak value of the impressed pulse voltage is 17V, and other conditions are the same as an example 1. A result is shown in Table 4.
[0134]
[Table 4]
Table [ ] 4 If (mA) Ie (muA) eta (%)
An example 6 1.0 6.5 0.65 An example 7 1.0 6.7 0.67 An example 8 1.2 6.1 0.51 An example 9 1.1 5.1 0.46 Example 3 of a comparison 1.8 2.0 0.11 (example 10) this example is an example of the electron source which carried out passive-matrix arrangement of many electron emission components. Some top views of an electron source are shown in drawing 14 . Moreover, the A-A' sectional view in drawing is shown in drawing 1515 .
[0135] here -- 1 -- for the direction wiring (it is also called upper wiring) of Y, and 2 and 3, as for a conductive thin film and 61, a component electrode, and 4 and 5 are [a substrate and 72 / the direction wiring of X (it is also called bottom wiring), and 73 / a layer insulation layer and 62] the contact holes for the electrical installation of the component electrode 2 and the bottom wiring 72.
[0136] Next, the manufacture approach is concretely explained in order of a process using drawing 16 and drawing 17 . In addition, process A-D corresponds to (a) - (d) of drawing 16 R> 6, and each process E-H corresponds to (a) - (d) of drawing 17 .
[0137] On the process-A substrate 1 formed by the spatter on the defecated blue plate glass, silicon oxide with a thickness of 0.5 micrometers with a vacuum deposition method After carrying out the laminating of Cr with a thickness of 5nm and the Au with a thickness of 600nm one by one, rotation spreading of the photoresist (AZ1370, Hoechst A.G. make) is carried out with a spinner. After BEKU, the photo mask image was exposed and developed, the bottom wiring 72 was formed, wet etching of the Au/Cr deposition film was carried out, and the wiring 72 under a desired configuration was formed.
[0138] The layer insulation layer 61 which becomes the Bth [-] process from silicon oxide with a thickness of 1.0 micrometers was deposited by RF spatter.
[0139] The photoresist pattern for forming a contact hole 62 in the silicon oxide deposited in process-C process-B was made, the layer insulation layer 61 was etched by having made this into the mask, and the contact hole 62 was formed. Etching is CF4. H2 It was based on the RIE (Reactive Ion Etching) method using gas.
[0140] After that [process-D], the pattern which should be set to the component electrode 2 and component electrode gap G was formed by the photoresist (RD-2000N-41, Hitachi Chemical Co., Ltd. make), and the sequential deposition of Ti with a thickness of 5nm and the nickel with a thickness of 100nm was carried out with the vacuum deposition method. A photoresist pattern is dissolved by the organic solvent, lift off of the nickel/Ti deposit is carried out, and it is the component electrode spacing L1. The component electrodes (20 micrometers and electrode length W2=300micrometer) 2 and 3 were deposited.
[0141] After forming the photoresist pattern of the upper wiring 73 on the -E process electrodes 2 and 3, Ti with a thickness of 5nm and Au with a thickness of 500nm were deposited with vacuum deposition one by one, lift off

removed the unnecessary part, and the upper wiring 73 of a desired configuration was formed.
[0142] Patterning of Process -F, next the Cr film 63 of 30nm of thickness was carried out so that it might have opening of the configuration of deposition and the conductive thin film 7 with vacuum deposition, and the conductive thin film 7 which performs rotation spreading and heating baking processing for [300 degrees-C] 12 minutes with a spinner, and consists the solution (ccp-4230: product made from Okuno Pharmaceuticals) of organic Pd compound of a PdO particle was formed on it. The thickness of this film was 70nm.
[0143] It removed with the garbage of the conductive thin film 7 which carries out wet etching of the process-GCr film 63 using etchant, and consists of a PdO particle, and the conductive thin film 7 of a desired configuration was formed. Resistance is Rs=4x104. They were omega / ** extent.
[0144] The resist pattern was formed in addition to the process-H contact hole 62 part, and the sequential deposition of Ti with a thickness of 5nm and the Au with a thickness of 500nm was carried out with vacuum deposition. The contact hole was embedded by removing an unnecessary part by lift off.
[0145] The process-I electron source substrate was installed in FIB processing equipment, and the same insulating region as an example 1 was formed in the conductive thin film of each electron emission component on a substrate.
[0146] Thus, the example which constituted image formation equipment using the created electron source is explained using drawing 18 .
[0147] After fixing the electron source substrate 71 on the rear plate 81, the face plate 86 (a fluorescent screen 84 and the metal back 85 are formed and constituted by the inside of a glass substrate 83) has been arranged through a housing 82 to 5mm upper part of a substrate 71, frit glass was applied to the joint of a face plate 86, a housing 82, and the rear plate 81, and it sealed by calcinating 400 degrees C for about 10 minutes in atmospheric air. Moreover, frit glass also performed immobilization of the substrate 71 to the rear plate 81. In drawing 18 , 74 is 72 and an electron emission component and 73 are component wiring of the direction of X, and the direction of Y, respectively.
[0148] In the case of monochrome, it consisted only of the fluorescent substance, but in this example, the fluorescent substance adopted the stripe configuration, and the fluorescent screen 84 formed the black stripe previously, applied each color fluorescent substance to the gap section, and produced the fluorescent screen 84. The ingredient which uses as a principal component the graphite used well was usually used as an ingredient of a black stripe. The approach of applying a fluorescent substance to a glass substrate 83 used slurry method.
[0149] Moreover, the metal back 85 is usually formed in the inside side of a fluorescent screen 84. The metal back smoothed the data of the inside side front face of a fluorescent screen after fluorescent screen production (usually called filming), and produced by vapor-depositing aluminum after that.
[0150] Since the conductivity of a fluorescent screen 84 is further raised to a face plate 86, a transparent electrode (un-illustrating) may be prepared in the external surface side of a fluorescent screen 84, but in this example, since conductivity sufficient in just the metal back was acquired, it omitted.
[0151] When performing the above-mentioned sealing, in the case of the color, sufficient alignment was performed in order to have to make each color fluorescent substance and an electron emission component correspond.
[0152] After exhausting the ambient atmosphere in the glassware of the image display device completed as mentioned above to about 10 - 4Pa with a vacuum pump through an exhaust pipe (not shown), the pressure in installation and a container is set to 2.7x10 to 2 Pa for n-hexane. As shown in drawing 19 , common connection of the direction wiring of Y is carried out, and activation is performed for every line. The common electrode with which 68 in drawing carried out common connection of the direction wiring 73 of Y, and 65 are oscilloscopes for a power source and 66 to carry out resistance for amperometries, and for 67 carry out the monitor of the current.
[0153] The impressed pulse voltage is the same as that of the case of an example 1. Having stopped installation of n-hexane after activation termination, having changed the exhauster to the ion pump, and heating the whole glassware at a heater, the inside of glassware was exhausted and the pressure was lowered up to 4.2x10 to 5 Pa.
[0154] Although this example showed the case where it wired in the shape of a matrix, even if it prepares the grid electrode further for a modulation, the equipment which has the same function can be formed using ladder-like wiring.
[0155] Then, the display function worked normally by matrix drive, after checking that the property was stable, it seals by heating a non-illustrated exhaust pipe with a gas burner, and the vacuum housing had been stopped. In order to maintain the degree of vacuum after the closure finally, getter processing was performed by the high-frequency-heating method.
[0156] In the image formation equipment of this invention completed as mentioned above for each electron emission component Through the container outer edge child Dx1 Dxm and Dy1 thru/or Dyn by impressing a scan signal and a modulating signal from a signal generation means by which it does not illustrate, respectively Carried out electron emission, and impressed the high pressure of 5.0kV to the metal back 85 or a transparent electrode (un-illustrating)

through the secondary terminal Hv, accelerated the electron beam, it was made to collide with a fluorescent screen 84, and the image was displayed by making light excite and emit.

[0157] Drawing 20 is drawing to show an example of the display constituted so that the image information supplied from the various sources of image information including television broadcasting could be displayed in the image formation equipment (image display panel) of an example 10. An image display panel and 131 130 in drawing The drive circuit of an image display panel, 132 a multiplexer and 134 for an image display panel controller and 133 A decoder, 135 CPU and 137 for an input/output interface circuit and 136 An image generation circuit, 138, and 139 and 140 An image memory interface circuitry, As for an image input interface circuitry, and 142 and 143, 141 is [TV signal receive circuit and 144] the input sections (in addition, this display). Although voice is naturally reproduced to a display and coincidence of an image when receiving the signal which contains image information and speech information like a television signal even if Explanation is omitted about a circuit, a loudspeaker, etc. about reception, separation, playback, processing, storage, etc. of the speech information which is not directly related to the description of this invention.

[0158] Hereafter, the function of each part is explained in accordance with the flow of a picture signal.

[0159] First, the TV signal receive circuit 143 is a circuit for receiving TV picture signal transmitted using radio-transmission systems, such as an electric wave and space optical communication. Especially the method of TV signal to receive may not be restricted and many methods, such as NTSC system, a PAL system, and an SECAM system, are sufficient as it. Moreover, TV signal (for example, the so-called high definition TV including MUSE) which consists of these from much scanning lines further is a suitable source of a signal to employ the advantage of said image display panel suitable for large-area-izing or large pixel number-ization efficiently. TV signal received by the TV signal receive circuit 143 is outputted to a decoder 134.

[0160] Moreover, the TV signal receive circuit 142 is a circuit for receiving TV picture signal transmitted using cable-transmission systems, such as a coaxial cable and an optical fiber. Like said TV signal receive circuit 143, especially the method of TV signal to receive is not restricted and TV signal received in this circuit is also outputted to a decoder 134.

[0161] Moreover, the picture signal which the image input interface circuitry 141 is a circuit for incorporating the picture signal supplied from picture input devices, such as a TV camera and an image reading scanner, and was incorporated is outputted to a decoder 134.

[0162] Moreover, the picture signal which the image memory interface circuitry 140 is a circuit for incorporating the picture signal currently recorded on the video tape recorder (it omits Following VTR), and was incorporated is outputted to a decoder 134.

[0163] Moreover, the picture signal which the image memory interface circuitry 139 is a circuit for incorporating the picture signal currently recorded on the videodisk, and was incorporated is outputted to a decoder 134.

[0164] Moreover, the static-image data which are a circuit for incorporating a picture signal and were incorporated are inputted into a decoder 134 from the equipment with which the image memory interface circuitry 138 is recording static-image data like the so-called still picture disk.

[0165] Moreover, the input/output interface circuit 135 is a circuit for connecting this display and output units, such as an external computer, a computer network, or a printer. Not to mention performing I/O of image data, or an alphabetic character and graphic form information, it is also possible to perform a control signal, I/O of numeric data, etc. between CPUs136 and the exteriors with which this indicating equipment is equipped depending on the case.

[0166] moreover, the image data, and an alphabetic character and graphic form information that the image generation circuit 137 is inputted from the outside through said input/output interface circuit 135 -- or it is a circuit for generating the image data for a display based on the image data, and the alphabetic character and graphic form information which are outputted from CPU136. The circuit required for generation including images, such as rewritable memory for accumulating image data, and an alphabetic character and graphic form information, read-only memory on which the image pattern corresponding to a character code is recorded, and a processor for performing an image processing, is included in the interior of this circuit.

[0167] Although the image data for a display generated by this circuit is outputted to a decoder 134, it is also possible to output to an external computer network and an external printer through said input/output interface circuit 135 depending on the case.

[0168] Moreover, CPU136 mainly does the activity in connection with the motion control of this display, generation of a display image, selection, or edit.

[0169] For example, a control signal is outputted to a multiplexer 133, and the picture signal displayed on an image display panel is chosen suitably, or is combined. moreover, the picture signal displayed in that case -- responding -- the

image display panel controller 132 -- receiving -- a control signal -- generating -- a screen-display frequency, a scan method (for example, is it an interlace or non-interlaced?), and a stroke -- actuation of displays, such as the number of the scanning lines of a field, is controlled suitably.
[0170] Moreover, the direct output of image data, or an alphabetic character and graphic form information is carried out, or an external computer and memory are accessed through said input/output interface circuit 135 to said image generation circuit 137, and image data, and an alphabetic character and graphic form information are inputted.
[0171] In addition, of course, CPU136 may be a **** thing also at the activity of the purposes other than this. For example, it is good for the function which generates information or is processed like a personal computer or a word processor in direct Seki. Or as mentioned above, it may connect with an external computer network through the input/output interface circuit 135, for example, the activity of numerical calculation etc. may be done in collaboration with an external instrument.
[0172] Moreover, the input section 144 is for a user to input an instruction, a program or data, etc. into said CPU136, for example, can use various input devices, such as a keyboard, a joy stick besides a mouse, a bar code reader, and a voice recognition unit.
[0173] Moreover, a decoder 134 is a circuit for carrying out inverse transformation of the various picture signals inputted from said image generation circuit 137 thru/or the TV signal receive circuit 143 to a three-primary-colors signal or a luminance signal and an I signal, and a Q signal. In addition, all over this drawing, as a dotted line shows, as for a decoder 134, it is desirable to equip the interior with an image memory. This is for treating TV signals which face carrying out inverse transformation and need an image memory including MUSE. Moreover, it is because the advantage that image processings and edits including infanticide of an image, interpolation, expansion, contraction, and composition can be easily performed now in collaboration with said image generation circuit 137 and CPU136 is born or the display of a still picture becomes easy by having an image memory.
[0174] Moreover, a multiplexer 133 chooses a display image suitably based on the control signal inputted from said CPU136. Namely, a multiplexer 133 chooses [from] a desired picture signal among the picture signals which are inputted from a decoder 134 and by which inverse transformation was carried out, and outputs it to the drive circuit 131. In that case, it is also possible by changing and choosing a picture signal within 1 screen-display time amount to display the image which divides one screen into two or more fields, and changes with fields like the so-called multi-screen television. Moreover, the image display panel controller 132 is a circuit for controlling actuation of the drive circuit 131 based on the control signal inputted from said CPU136.
[0175] First, the signal for controlling this ** sequence of the power source for a drive of for example, an image display panel (not shown) is outputted to fundamental actuation of an image display panel to the drive circuit 131 as a **** thing.
[0176] Moreover, the signal for controlling for example, an image display frequency and a scan method (for example, is it an interlace or non-interlaced?) is outputted to the drive approach of an image display panel to the drive circuit HH131 as a **** thing.
[0177] Moreover, depending on the case, a **** control signal may be outputted to adjustment of the brightness and contrast of a display image, a color tone, or the image quality of sharpness to the drive circuit 131.
[0178] Moreover, the drive circuit 131 is a circuit for generating the driving signal impressed to the image display panel 130, and operates based on the picture signal inputted from said multiplexer 133, and the control signal inputted from said image display panel controller 132.
[0179] As mentioned above, although the function of each part was explained, it is possible to display the image information inputted from the various sources of image information in this display by the configuration illustrated to drawing 20 on the image display panel 130. That is, after inverse transformation of various kinds of picture signals including television broadcasting is carried out in a decoder 134, they are suitably chosen in a multiplexer 133 and are inputted into the drive circuit 131. On the other hand, the image display panel controller 132 generates the control signal for controlling actuation of the drive circuit 131 according to the picture signal to display. The drive circuit 131 impresses a driving signal to the image display panel 130 based on the above-mentioned picture signal and a control signal. Thereby, an image is displayed in the image display panel 130. These the actuation of a series of is controlled by CPU136 in the gross.
[0180] Moreover, in this indicating equipment, it is possible in it not only displaying the image memory built in said decoder 134, and the thing chosen from the image generation circuit 137 and information, but carrying out Fig. edits including a face, such as composition including image processings, such as expansion, contraction, rotation, migration, edge enhancement, infanticide, interpolation, color conversion, and aspect ratio conversion of an image, elimination, connection, exchange, and fitting, as opposed to the image information to display. Moreover, although especially

explanation of this example did not describe, the specialized circuit for performing processing and edit also about speech information may be prepared like the above-mentioned image processing or image edit.

[0181] Therefore, this indicating equipment can have functions, such as terminal equipments for office work including the image edit device treating the display device of television broadcasting, the terminal equipment of a television conference, a static image, and a dynamic image, the terminal equipment of a computer, and a word processor, and a game machine, by one set, and its application range is very wide as industrial use or a noncommercial use.

[0182] In addition, it cannot be overemphasized that it is not what does not pass over above-mentioned drawing 20 for an example of the configuration of the display using the image display panel which makes an electron emission component the source of an electron beam to have been shown, but is limited only to this. For example, even if it excludes a **** circuit to the function which does not have the purpose-of-use top need among the components of drawing 20 , it is not hindered by it. Moreover, contrary to this, a component may be further added depending on the purpose of use. For example, when applying this indicating equipment as a TV phone machine, it is suitable to add the transceiver circuit containing a television camera, a voice microphone, an illuminator, and a modem etc. to a component.

[0183] (Example 11) It had the same process as said example 10, and image formation equipment was produced. However, the configuration of the insulating region formed in process-I presupposed that it is the same as that of an example 7.

[0184] Consequently, the good image display device was able to be obtained like the example 10.

[0185] (Example 12) The electron emission component of this example has the configuration same with having been shown in drawing 21 . Drawing 21 (a) is a top view and drawing 21 (b) is a sectional view. As for a component electrode, and 1204 and 1205, for 1, a substrate, and 1202 and 1203 are [a conductive thin film and 1206] cracks, i.e., the electron emission section. The gap width of face G of an electrode is taken here so that it may become fixed. In addition, le, lp, and la will be defined along with the center line of an electrode gap. However, since this example forms the crack 1206 by foaming so that it may mention later, the crack 1206 is not necessarily formed along with the center line, and is not necessarily the same at all. [of the configuration of the crack 1206 for every pattern]

[0186] The manufacture approach of the electron emission component of this example is explained using drawing 22 and drawing 3 . The outline of the manufacture approach is the same as that of JP,7-2355255,A stated by the Prior art almost. A different part from the contents stated by the Prior art is described in detail below.

[0187] The component electrodes 1202 and 1203 with the configuration shown in process-a drawing 22 (a) were formed by the lift-off method on the substrate 1 which consists of silicon oxide (0.5 micrometers) / blue plate glass by nickel (100nm) / Ti (5nm) deposition film by the same approach as the Prior art described. In addition, in this example, they could be Ie=10micrometer, lp=20micrometer, la =50micrometer, and G= 5 micrometers.

[0188] Process - The location shown in b and c drawing 22 (b) and the conductive thin film 7 of a configuration were formed by the oxidation Pd particle film (10nm) by the same approach as the Prior art described. In addition, in this example, the average of the distance P which connects the border of a conductive thin film and the border of the component electrode 1202 was about 17.5 micrometers.

[0189] By the same approach (foaming processing), as shown in drawing 22 (c), the crack 1206 was formed in some conductive thin films 7 as the process-d Prior art described.

[0190] In addition, in this example, using the triangular wave, pulse width T1 of a voltage waveform was set to 1msec, pulse separation T2 were set to 10msec(s), the pressure up of the peak value (peak voltage at the time of foaming) of a triangular wave was carried out to **** at 0.1V step, and it performed foaming processing. Moreover, the electrical potential difference at the time of foaming termination was 5V.

[0191] By the same approach (activation), the component current If and the emission current Ie which were 0 changed remarkably, and came to increase before activation, and the electron emission section was formed in the crack 1206 as the process-e Prior art described.

[0192] In addition, in this example, using the square wave, pulse width T1 of a voltage waveform was set to 1msec, pulse width T2 was set to 10msec(s), peak value (peak voltage at the time of activation) of a square wave was set to 15V, and activation was performed for 60 minutes under the vacuum ambient atmosphere of about 1.3x10 to 1 Pa which carried out evacuation with the rotary pump.

[0193] About the component produced as mentioned above, the electron emission characteristic was measured with the measurement evaluation equipment of the configuration of drawing 2 . In addition, in this example, the degree of vacuum in 1kV and the vacuum devices at the time of electron emission characteristic measurement was set [the distance between a raising electrode and an electron emission component] to 1.3x10 to 4 Pa for the potential of 4mm and a raising electrode.

0194] The component electrical potential difference was impressed among the component electrodes 1202 and 1203 of his electron emission component using the above measurement evaluation equipments, and when the component :urrent If and the emission current Ie which flow then were measured, the current-voltage characteristic as shown in lrawing 4 was acquired. With this component, the emission current Ie increased from about component electrical-)otential-difference 7V rapidly, by component electrical-potential-difference 14V, the component current If was set to ..2mA, the emission current Ie was set to 3.6microA, and electron emission effectiveness eta=Ie/If (%) was 0.3%.
0195] Moreover, since this electron emission component shows the same electron emission characteristic as the Prior ırt described, as stated to JP,7-2355255,A, it can be similarly constituted as an image display device by arranging many ›lectron emission components in the shape of a matrix.
0196] The image display device obtained similarly is what has high effectiveness as compared with conventional ›lectron emission equipment equipped with the property of the electron emission equipment of this invention.
0197] (Example 13) Process in said example 12 - The electron emission component was produced like the example 12 ›xcept having changed b and c into following process b' and c'.
0198] The water solution of 40 % of the weight of process-b dimethyl sulfoxide was prepared, it dissolved so that it night become 0.4% of palladium weight concentration about acetic-acid palladium at this, and the solution of low red ıeat was obtained.
0199] The ink jet equipment 151 of process-c' Bubble Jet gave the drop 152 of the above-mentioned low-red-heat solution so that some component electrodes 1202 and 1203 might be straddled on the substrate 1 in which the :omponent electrodes 1202 and 1203 were formed ((a) of drawing 23). 153 is the drop given to the substrate 1 here. Next, it was made to dry at 80 degrees C for 2 minutes. Next, the conductive thin film 7 which calcinates at 350 legrees C for 12 minutes, and mainly consists of oxidization palladium was formed ((b) of drawing 23). In addition, in his example, the average of the distance P which connects the border of the conductive thin film 7 and the border of he component electrode 1202 was 17.5 micrometers.
0200] When the same approach as an example 12 estimated the electron emission characteristic, in component electrical-potential-difference 14V, the component current If was set to 1.0mA, the emission current Ie was set to 2.8microA, and electron emission effectiveness eta=Ie/If (%) was 0.28%.
0201] (Example 14) In the example 12, the electron emission component was similarly produced except having been referred to as Ie=5micrometer, lp=20micrometer, and la=50micrometer.
[0202] When the same approach as an example 12 estimated the electron emission characteristic, in component electrical-potential-difference 14V, the component current If was set to 1.2mA, the emission current Ie was set to 5.0microA, and electron emission effectiveness eta=Ie/If (%) was 0.50%.
[0203] (Example 15) The same electron emission component as an example 13 was produced except having been referred to as Ie=5micrometer, lp=20micrometer, and la=50micrometer.
[0204] When the same approach as an example 12 estimated the electron emission characteristic, in component electrical-potential-difference 14V, the component current If was set to 1.0mA, the emission current Ie was set to 4.5microA, and electron emission effectiveness eta=Ie/If (%) was 0.45%.
[0205] (Example 16) The electron emission component of this example has the configuration same with having been shown in drawing 24 (a). For 1, as for a component electrode and 7, a substrate, and 2 and 3 are [a conductive thin film and 1606] cracks, i.e., the electron emission section. In addition, it will define by Ie=S1-2S2, Ip=S1+S3, and la=T1. However, since this example forms the crack 1606 by foaming so that it may mention later, the crack 1606 is not necessarily formed in the shape of a straight line, and is not necessarily the same at all. [of the configuration of the crack 1606 for every pattern]
[0206] The manufacture approach of the electron emission component of this example is explained using drawing 3 and drawing 24 (a).
[0207] Process - (1)
The laminating of Ti with a thickness of 5nm and the Pt with a thickness of 30nm was carried out to the quartz-glass substrate 1 washed by neutral detergent, pure water, and the organic solvent one by one with the vacuum deposition method. After having exposed, having used the photo mask, having developed it continuously, after having continued, the photoresist (AZ1370; Hoechst A.G. make) and forming a resist layer, and forming the resist pattern of the component electrodes 2 and 3, wet etching of the unnecessary part of the Pt/Ti film was carried out, it was removed, finally the organic solvent removed the resist pattern, and the component electrodes 2 and 3 were formed. [applied and] 10 micrometers and the electrode length W2 set spacing L1 of a component electrode to 100 micrometers (drawing 3 (a)).
[0208] Process - (2)

With the vacuum deposition method, opening corresponding to the configuration of a conductive thin film for Cr film (un-illustrating) with a thickness of 50nm was formed by the technique of deposition and the usual photolithography, and it considered as Cr mask.

[0209] It continued, and acetic-acid palladium monoethanolamine (henceforth, PAME) was heated at 310 degrees C in rotation spreading and atmospheric air with the spinner, and was calcinated, and the thin film which consists of a particle which uses oxidization palladium (PdO) as a principal component was formed. Then, the conductive thin film 7 which has the pattern of removal and a request by lift off of Cr mask by wet etching was formed. The resistance of a conductive thin film is Rs=4.0x104. They were omega/** (drawing 3 (b)).

[0210] Process - (3)

The above-mentioned component was allotted on the stage with x and y drive pulse motor, using the oscillation line with an excitation wavelength [of Ar ion laser] of 514.5nm, the above-mentioned laser was irradiated so that it might be set to 10mW on a conductive thin film, the metal Pd part was removed by moving x and y stage, and the insulating region of a configuration as shown in drawing 24 (a) was formed. Width of face of an insulating region was set to S1=5micrometer, S2=1micrometer, S3=5micrometer, and T1=7micrometer. Therefore, it is defined as Ie=3micrometer, lp=10micrometer, and la=7micrometer.

[0211] Process - (4)

Next, after having installed this component in the measurement evaluation equipment of drawing 2 , exhausting with the vacuum pump and reaching the pressure of 2.0x10 to 3 Pa, the pulse voltage was impressed between the component electrode 2 and 3, respectively from the power source 10 for impressing the component electrical potential difference Vf to a component, and the crack 1606 was formed by performing energization processing (foaming processing).

[0212] After the component current If became sufficiently small, electrical-potential-difference impression was ended and it was left under the hydrogen ambient atmosphere for 1 hour, and reduction processing was performed so that the conductive thin film 7 might be completely consisted of a metal Pd.

[0213] Process - (5)

Next, vacuum devices 16 were again exhausted with the vacuum pump 15, and the pressure was set to 2.0x10 to 3 Pa. Then, activation was performed, having impressed the pulse voltage between the component electrode 2 and 3, and measuring the component current If from the power source 10 for impressing the component electrical potential difference Vf to a component. Before activation, the component current If which was 0 substantially changes remarkably, and came to increase, and since the component current If was saturated in about 30 minutes, processing was ended. The used pulse is a square wave pulse and pulse width T1=0.5msec, pulse-separation T2=10msec, and peak value are 16V.

[0214] Process - (6)

The exhauster was changed to the ion pump, and it exhausted, heating the vacuum-devices 16 whole at about 200 degrees C. The pressure declined up to 1.3x10 to 7 Pa 24 hours after. In order to grasp the property of the surface conduction mold electron emission component produced at the above-mentioned process, the evaluation equipment of above-mentioned drawing 2 was used, and the electron emission characteristic of a component was performed.

[0215] (Example 4 of a comparison) Process [- (4) - process / - The electron emission section was formed by giving the process of (6).] of an example 1 - (1) and process - Process after performing the same process as (2) - (3) is not performed but it is a process.

[0216] Process - (7)

In order to grasp the property of the surface conduction mold electron emission component produced in the above-mentioned example 16 and the example 2 of a comparison, the electron emission characteristic was measured with the evaluation equipment of drawing 2 . These electron emission components and the raising electrode 12 are installed in vacuum devices 16, and the device required for vacuum devices, such as an exhaust air pump for forming a non-illustrated high vacuum and a vacuum system, possesses them in the vacuum devices, and they can perform measurement evaluation of this component now under a desired vacuum. in addition, the pulse voltage which impressed the square wave pulse voltage of pulse height value 15V to the component at 3 sides, and was impressed -- pulse width T1=0.1msec and pulse-separation T -- 2= 25 msec, it came out, and pulled up with the component, and, in the distance H of an electrode, the potential of 4mm and a raising electrode set the pressure at the time of 1kV and the electron emission characteristic to 2.0x10 to 7 Pa. A result is shown in Table 5. In addition, eta shows electron emission effectiveness (Ie/If).

[0217]

[Table 5]

Table [ ] 5 If (mA) Ie (muA) eta (%)

Example 16 1.1 5.1 0.46 Example 4 of a comparison 2.5 2.5 According to 0.10 this example, it has checked that an efficient component was easily producible by applying this invention.
[0218] (Example 17) Process of an example 16 - (1) and process - Process after performing the same processing as (2) - (3)
It is the process of an example 16 about a component. - It allotted the same equipment as (3), and insulating region formation was performed. The configuration of an insulating region is shown in drawing 24 (b).
[0219] In addition, it was made for the width of face of an insulating region to be set to S4=1micrometer, S5=5micrometer, S6=10micrometer, and T2=7micrometer.
[0220] Process - (4)
The above-mentioned component is installed in the vacuum processor of drawing 2 ; and it is the process of an example 1. - The crack 1606 was formed by performing the same foaming processing as (4), and reduction processing.
[0221] Then, the inside of vacuum devices 16 was once exhausted to the high vacuum with the vacuum pump 15, the acetone was introduced, and the pressure was set to 2.5x10 to 1 Pa. The pulse voltage was impressed among the component electrodes 2 and 3, and activation was performed. The used pulse is a square wave pulse and pulse width T1=1msec, pulse-separation T2=10msec, and peak value were made to increase gradually from 10V to 18V at the rate of 0.2 V/min.
[0222] Process - (5)
Installation of an acetone was stopped, and it exhausted with the exhauster 115, heating the vacuum-devices 16 whole at about 200 degrees C. The pressure declined up to 1.3x10 to 7 Pa 24 hours after. In order to grasp the property of the surface conduction mold electron emission component produced at the process of this example, the electron emission characteristic was measured with the evaluation equipment of the same drawing 2 as an example 1. The pulse voltage impressed to the component is the same as that of an example 1. The pressure at the time of the electron emission characteristic was set to 2.0x10 to 7 Pa.
[0223] The emission current Ie increased rapidly the component produced by this example from about component electrical-potential-difference 10V, in component electrical-potential-difference 15V, the component current If was set to 1.1mA, the emission current Ie was set to 6.4microA, and the electron emission effectiveness eta was 0.58%.
[0224] (Example 18) Process of an example 16 - In (3), other processes performed the completely same processing as an example 16 except the point using a focused ion beam. When the pressure was set to 2.0x10 to 7 Pa and the electron emission characteristic was finally measured on an example 16 and these conditions with the evaluation equipment of drawing 2 , in component electrical-potential-difference 15V, the component current If was set to 1.0mA, the emission current Ie was set to 5.1microA, and the electron emission effectiveness eta was 0.51%.
[0225] (Example 19) Process of an example 16 - In (3), other processes performed the completely same processing as an example 16 except the point which made Nd:YAG laser used laser. When the pressure was set to 2.0x10 to 7 Pa and the electron emission characteristic was finally measured on an example 16 and these conditions with the evaluation equipment of drawing 2 , in component electrical-potential-difference 15V, the component current If was set to 1.3mA, the emission current Ie was set to 5.1microA, and the electron emission effectiveness eta was 0.40%.
[0226] (Example 20) Process of an example 16 - In (2), as the technique of the usual photolithography was applied and the pattern after lift off became drawing 24 (a), the insulating region was formed in formation of the conductive thin film 7, and a list at coincidence. Others performed the completely same processing as an example 16. When the pressure was set to 2.0x10 to 7 Pa and the electron emission characteristic was finally measured on an example 1 and these conditions with the evaluation equipment of drawing 2 , in component electrical-potential-difference 15V, the component current If was set to 1.2mA, the emission current Ie was set to 5.0microA, and the electron emission effectiveness eta was 0.41%.
[0227] According to this example, since formation of a conductive thin film and formation of an insulating region were performed to coincidence, the manufacture approach by this invention could be applied quickly, and the surface conduction mold electron emission component was able to be produced to homogeneity.
[0228] (Example 21) Image formation equipment was produced like the example 10 except having changed the process I in said example 10 into following process I'.
[0229] The process-I' electron source substrate was arranged on the stage with x and y drive pulse motor, using the oscillation line with an excitation wavelength [of Ar ion laser] of 514.5nm, the above-mentioned laser was irradiated so that it might be set to 10mW on a conductive thin film, by moving x and y stage, the metal Pd part was removed and the same insulating region as an example 17 was formed.
[0230] Next, after having installed this component in the measurement evaluation equipment of drawing 2 , exhausting with the vacuum pump and reaching the pressure of 2.0x10 to 3 Pa, the pulse voltage was impressed between the

component electrode 2 and 3, respectively from the power source 10 for impressing the component electrical potential difference Vf to a component, and the crack 6 was formed by performing energization processing (foaming processing).
[0231] After the component current If was completely set to 0, electrical-potential-difference impression was ended and it was left under the hydrogen ambient atmosphere for 1 hour, and reduction processing was performed so that the conductive thin film 7 might be completely consisted of a metal Pd.
[0232] Consequently, the good image display device was able to be obtained like the example 10.
[0233] (Example 22) This example explains an example in case the electron emission section which followed the whole insulating region is formed.
[0234] In this example, the electron emission component was produced like the example 1. However, in process-c, the insulating region formed with focusing ion beam machining equipment was made into the configuration shown in drawing 13 (a), and the width of face of this insulating region adjusted all (parts of a thick wire and a thin line) so that it might be set to 40nm. In addition, they could be Ie=5micrometer, Ip=10micrometer, and Ia=10micrometer.
[0235] About the component of the above-mentioned example, the electron emission characteristic was measured with the equipment of drawing 2 . At that time, the pulse voltages impressed to the component were pulse width T1= 100microsec, pulse-separation T2=10msec, and the square wave pulse of pulse height value 15V, it pulled up with the component and the distance H of an electrode set potential of 4mm and a raising electrode to 1kV. Consequently, component current If=2.5mA, emission current Ie=5.2microA, and eta= 0.21% of electron emission effectiveness were acquired.
[0236]
[Effect of the Invention] As explained above, by this invention, electron emission effectiveness is high and the high image of grace is obtained in the image display device using the electron source which the electron emission component by which the property was controlled by stability is offered, and comes to accumulate these a majority of components.

[Translation done.]

NOTICES *

PO and NCIPI are not responsible for any
amages caused by the use of this translation.

.This document has been translated by computer. So the translation may not reflect the original precisely.
.**** shows the word which can not be translated.
.In the drawings, any words are not translated.

›ESCRIPTION OF DRAWINGS

3rief Description of the Drawings]
Drawing 1] The basic block diagram of the surface conduction mold electron emission component of this invention.
Drawing 2] The explanatory view of the electron emission equipment using the surface conduction mold electron mission component of this invention.
Drawing 3] Drawing explaining the manufacture approach of the surface conduction mold electron emission omponent of this invention.
Drawing 4] The current characteristic Fig. of the electron emission equipment using the surface conduction mold lectron emission component of this invention.
Drawing 5] The characteristic potential distribution map of the electron emission equipment using the conventional urface conduction mold electron emission component.
Drawing 6] The characteristic potential distribution map of the electron emission equipment using the conventional urface conduction mold electron emission component.
Drawing 7] The explanatory view of potential distribution to the potential appointed boundary which exists in a flat urface and which was made binary.
Drawing 8] The characteristic potential distribution map of the electron emission equipment using a surface onduction mold electron emission component with a straight-line crack and a meandering crack.
Drawing 9] The explanatory view of the effectiveness of meandering in the conventional component.
Drawing 10] Drawing showing the parameter dependency of controlled meandering.
Drawing 11] Drawing showing the example of special meandering.
Drawing 12] Drawing showing the la dependency of controlled meandering.
Drawing 13] Drawing showing an example of the surface conduction mold electron emission component of this ıvention.
Drawing 14] The part plan showing the configuration of the electron source of the matrix array of this invention.
Drawing 15] Drawing showing the configuration of the cross section in alignment with A-A' of drawing 14 .
Drawing 16] Drawing for explaining the production process of the electron source of the matrix array of this nvention.
Drawing 17] Drawing for explaining the production process of the electron source of the matrix array of this nvention.
Drawing 18] Drawing showing the configuration of the image formation equipment using the electron source of the natrix array of this invention.
Drawing 19] The mimetic diagram showing wiring for the activation in the case of manufacture of the electron source ›f the matrix array of this invention, and image formation equipment.
Drawing 20] The block diagram showing an example of the image display system using the image formation :quipment of this invention.
Drawing 21] Drawing explaining an example of the surface conduction mold electron emission component of this nvention.
Drawing 22] Drawing explaining an example of the manufacture approach of the surface conduction mold electron :mission component of this invention.
Drawing 23] Drawing explaining an example of the manufacture approach of the surface conduction mold electron :mission component of this invention.
Drawing 24] Drawing explaining an example of the surface conduction mold electron emission component of this nvention.

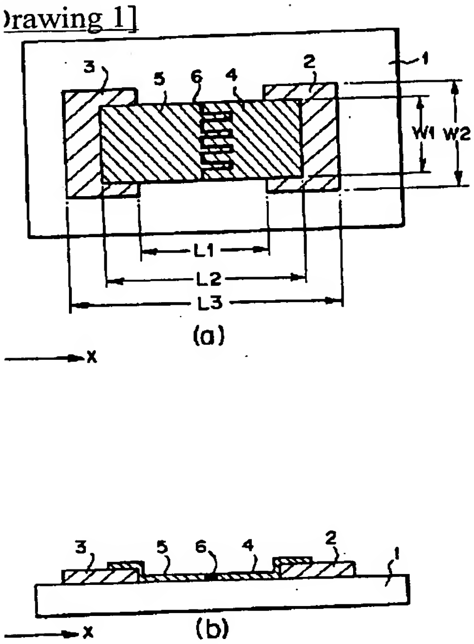
[Drawing 25] The basic block diagram of the surface conduction mold electron emission component of this invention.
[Drawing 26] The explanatory view of the electron emission equipment using the surface conduction mold electron emission component of this invention.
[Drawing 27] Drawing explaining the manufacture approach of the surface conduction mold electron emission component of this invention.
[Drawing 28] The current characteristic Fig. of the electron emission equipment using the surface conduction mold electron emission component of this invention.
[Description of Notations]
1 Substrate
2 Three Component electrode
4, 5, 7 Conductive thin film
6 Crack
10 Power Source
12 Raising Electrode
11 14 Ammeter
13 High Voltage Power Supply
15 Vacuum Pump
16 Vacuum Housing
30 Crack
31 High Potential Thin Film Section
32 Low Voltage Thin Film Section
33 Raising Electrode
34 Considered Field
35 Stagnation Point
36 Negative Inclination Field of the Conventional Component
38 Heights
39 Crevice
40 Negative Inclination Field of Component of this Invention
61 Layer Insulation Layer
62 Contact Hole
63 Cr Film
65 Power Source
66 Resistance for Amperometries
67 Oscilloscope
68 Common Electrode
71 Substrate
72 The Direction Wiring of X
73 The Direction Wiring of Y
74 Electron Emission Component
81 Rear Plate
82 Housing
83 Glass Substrate
84 Fluorescent Screen
85 Metal Back
86 Face Plate
130 Image Display Panel
131 Drive Circuit
132 Image Display Panel Controller
133 Multiplexer
134 Decoder
135 Input/output Interface Circuit
136 CPU
137 Image Generation Circuit
138-140 Image input memory interface circuitry

141 Image Input Interface Circuitry
142 143 TV signal receive circuit
144 Input Section
151 Ink Jet Equipment
152 Drop
153 Drop Given to Substrate
1202 1203 Component electrode
1204 1205 Conductive thin film
1206 Crack
1606 Crack
5004 5005 Conductive thin film
5006 Crack

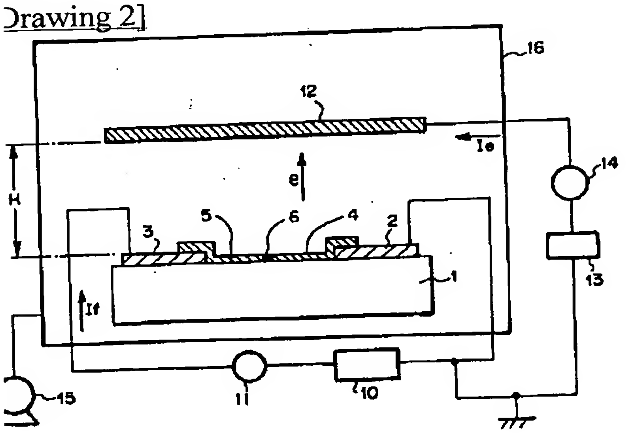
[Translation done.]

RAWINGS

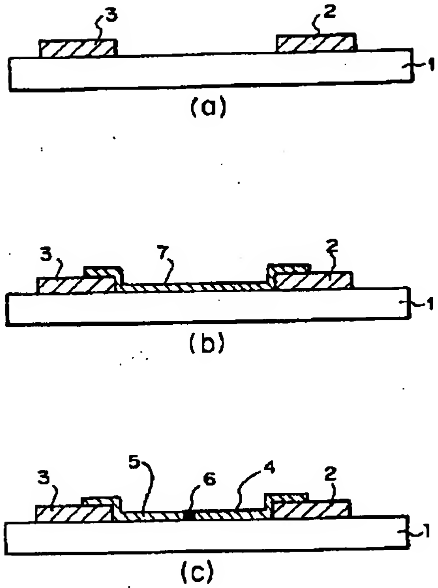
)rawing 1]



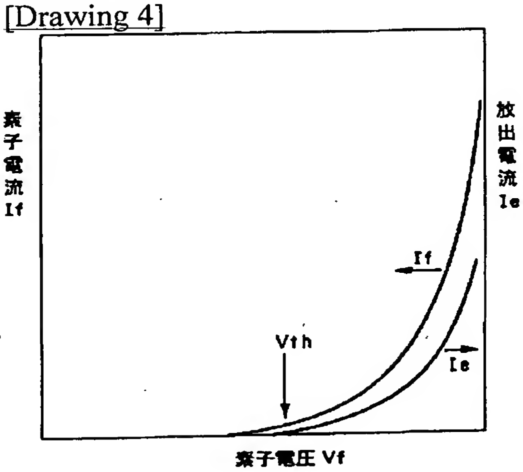
Drawing 2]



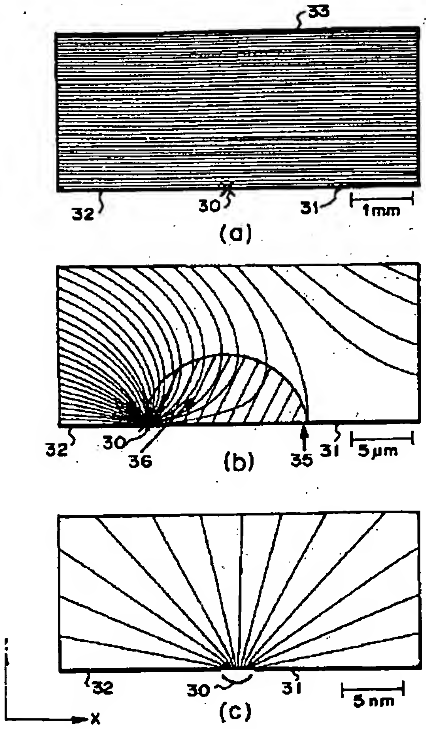
Drawing 3]



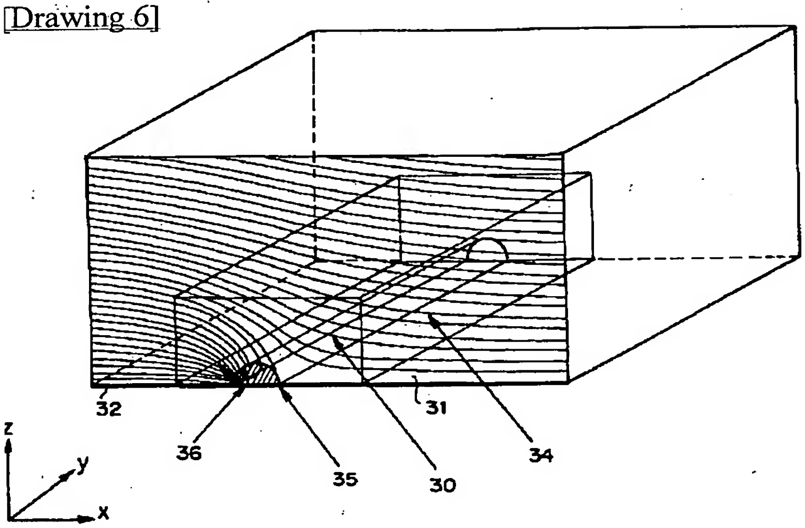
[Drawing 4]



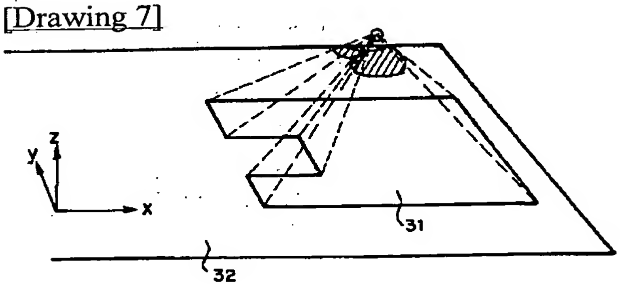
[Drawing 5]



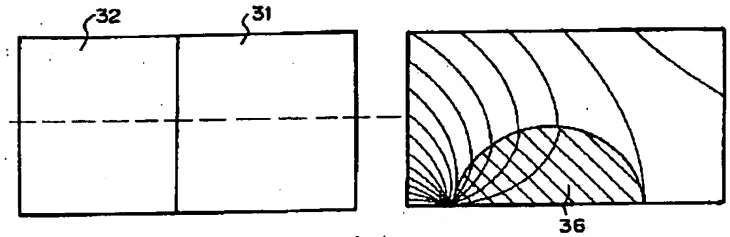
[Drawing 6]



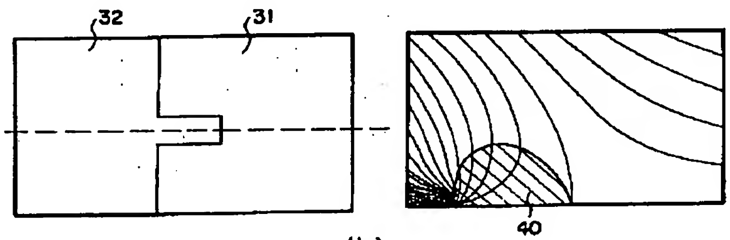
[Drawing 7]



[Drawing 8]

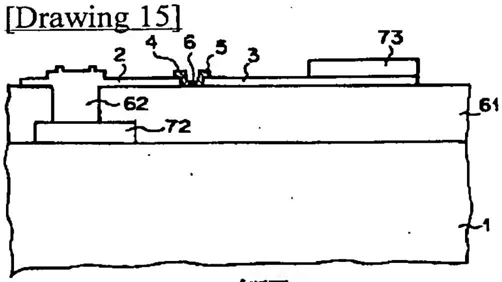


(a)



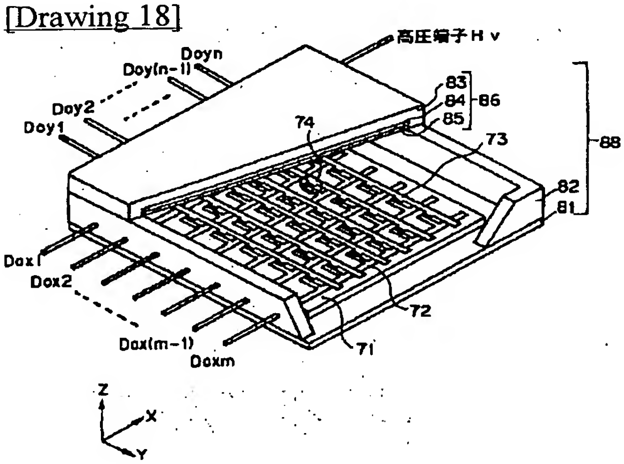
(b)

[Drawing 15]



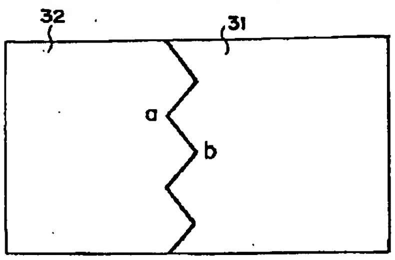
A－A'断面

[Drawing 18]

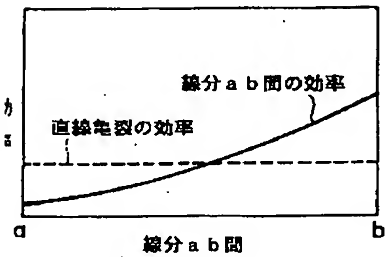


[Drawing 9]

来の素子における蛇行の効果に関する図



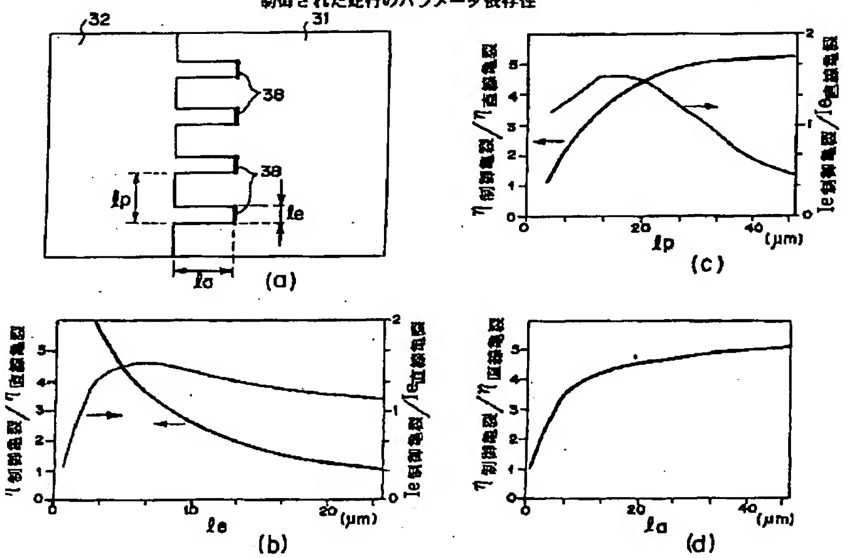
(a)



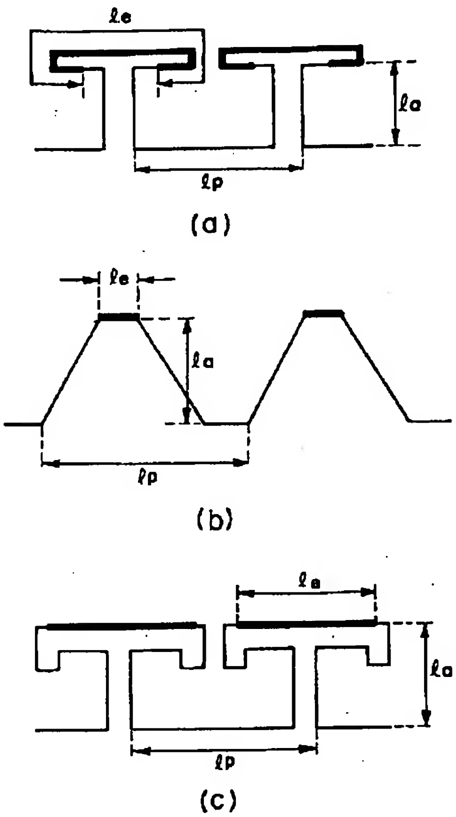
(b)

Drawing 10]

制御された蛇行のパラメータ依存性

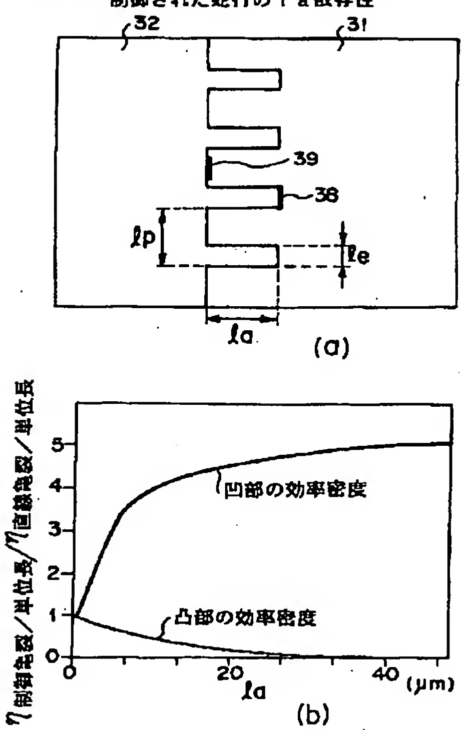


Drawing 11]

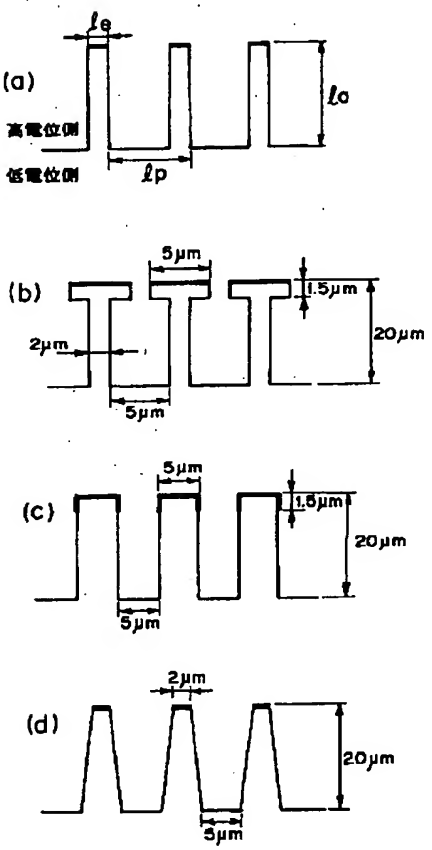


[Drawing 12]

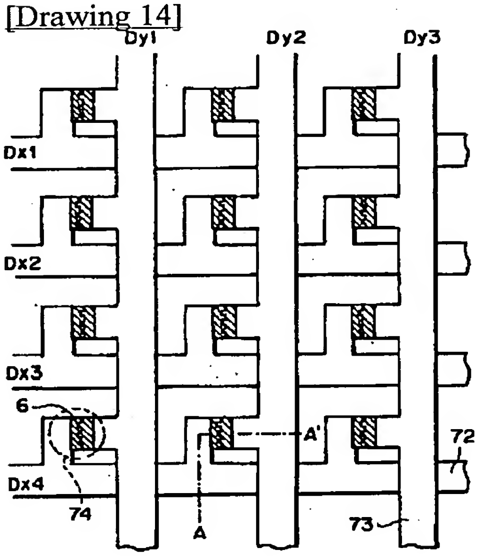
制御された蛇行のｌａ依存性



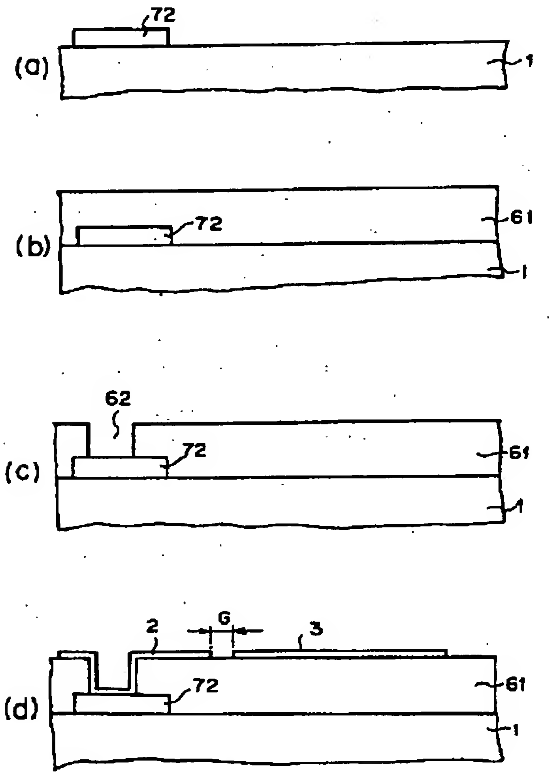
[Drawing 13]



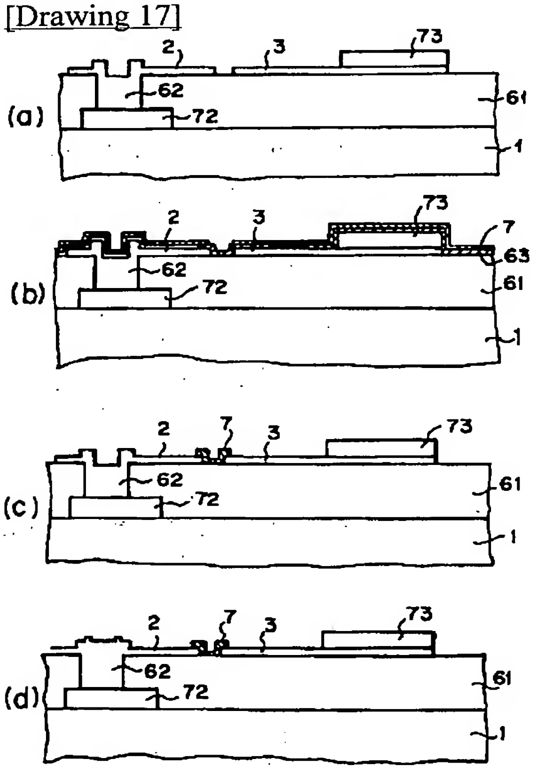
[Drawing 14]



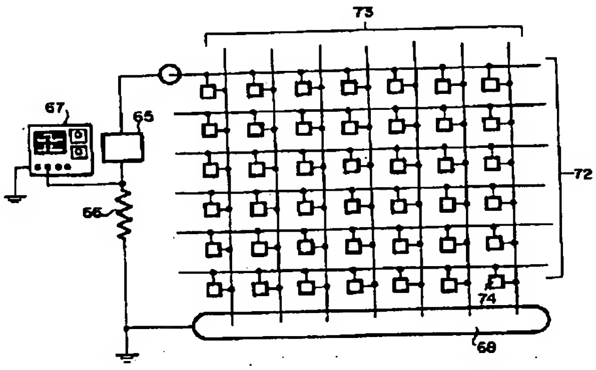
[Drawing 16]



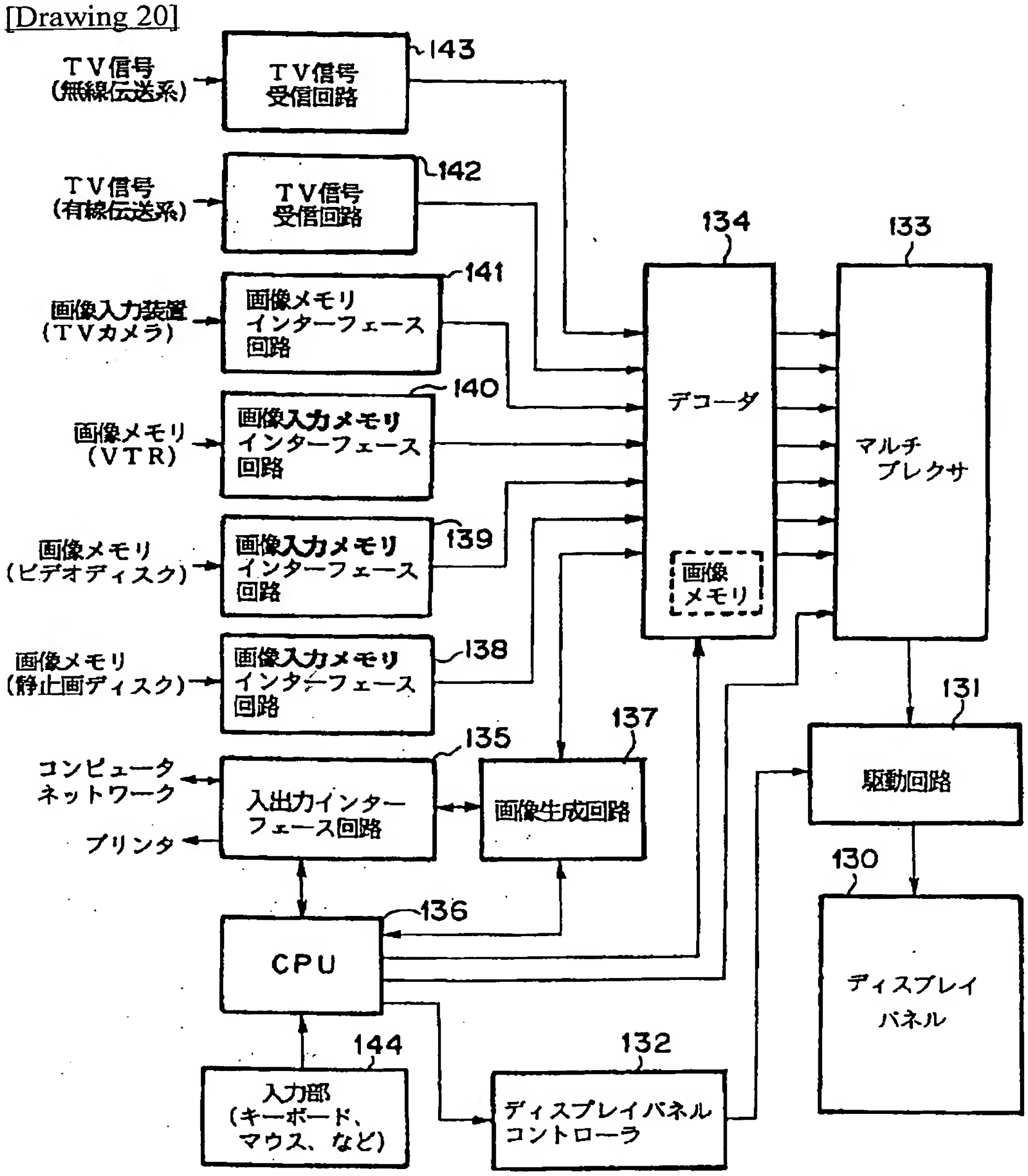
[Drawing 17]



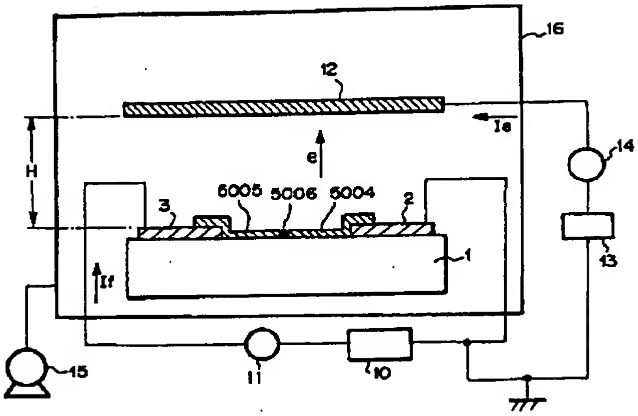
[Drawing 19]



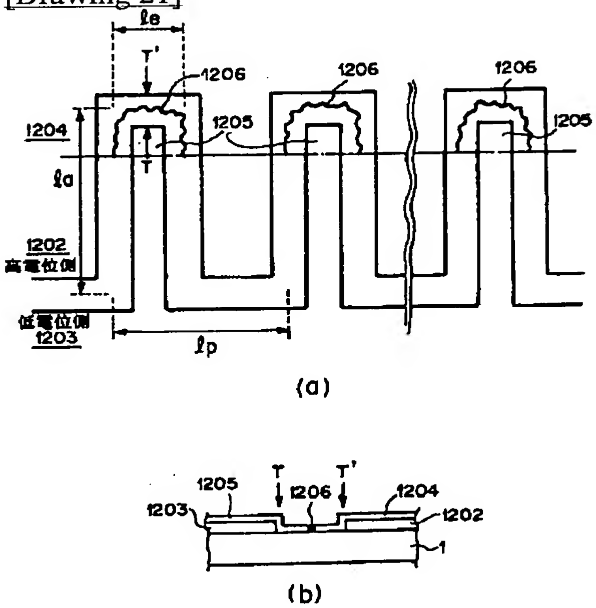
[Drawing 20]



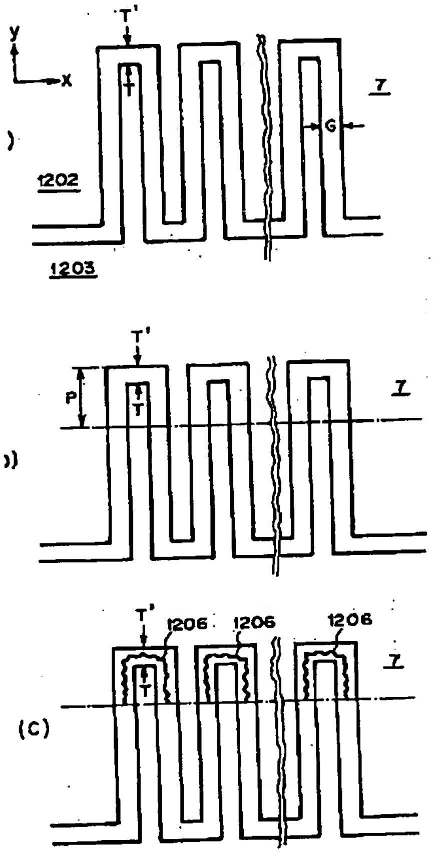
[Drawing 26]



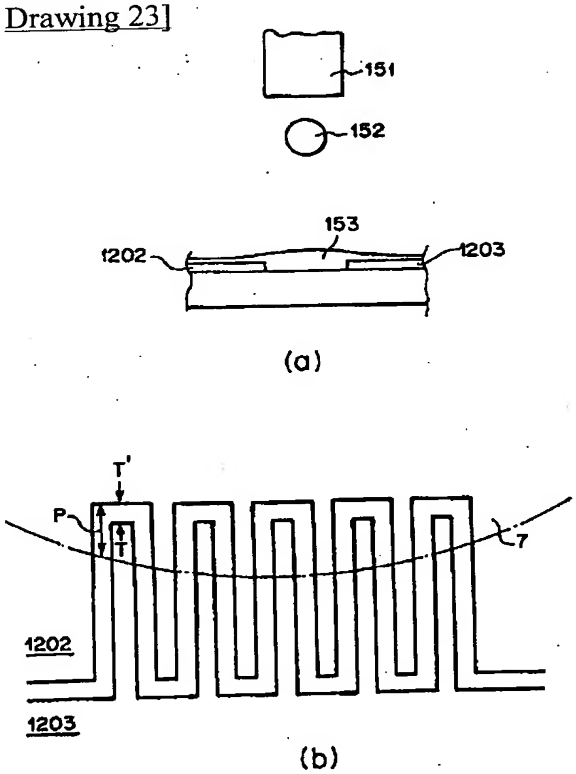
[Drawing 21]



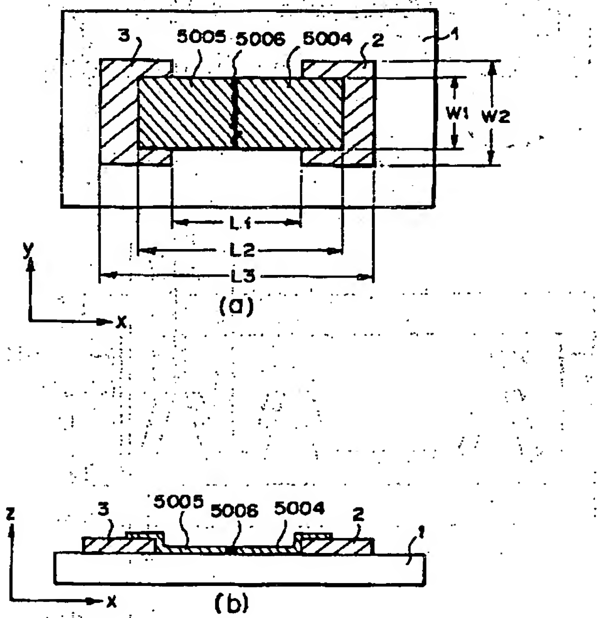
[Drawing 22]



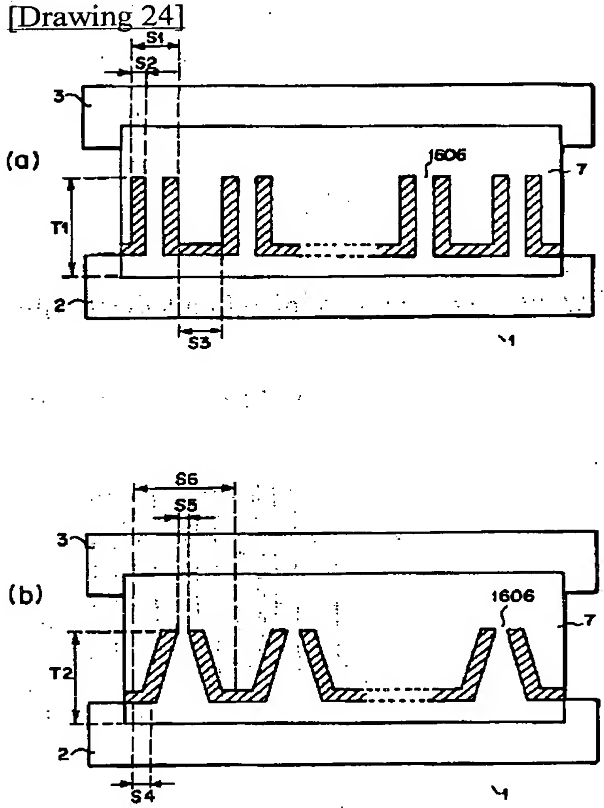
[Drawing 23]



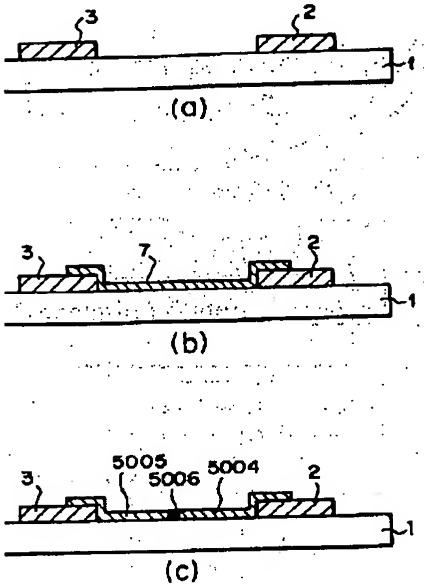
[Drawing 25]



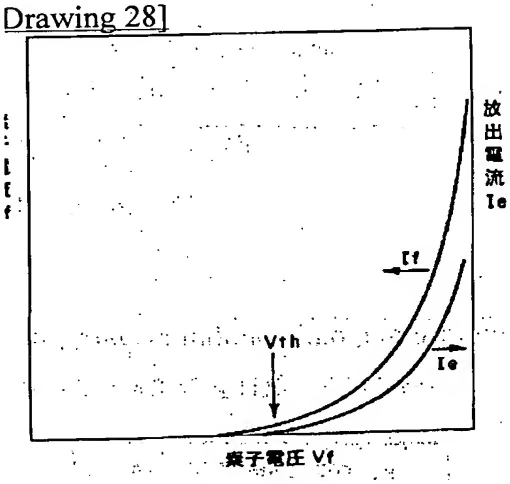
[Drawing 24]



[Drawing 27]



Drawing 28]



Translation done.]